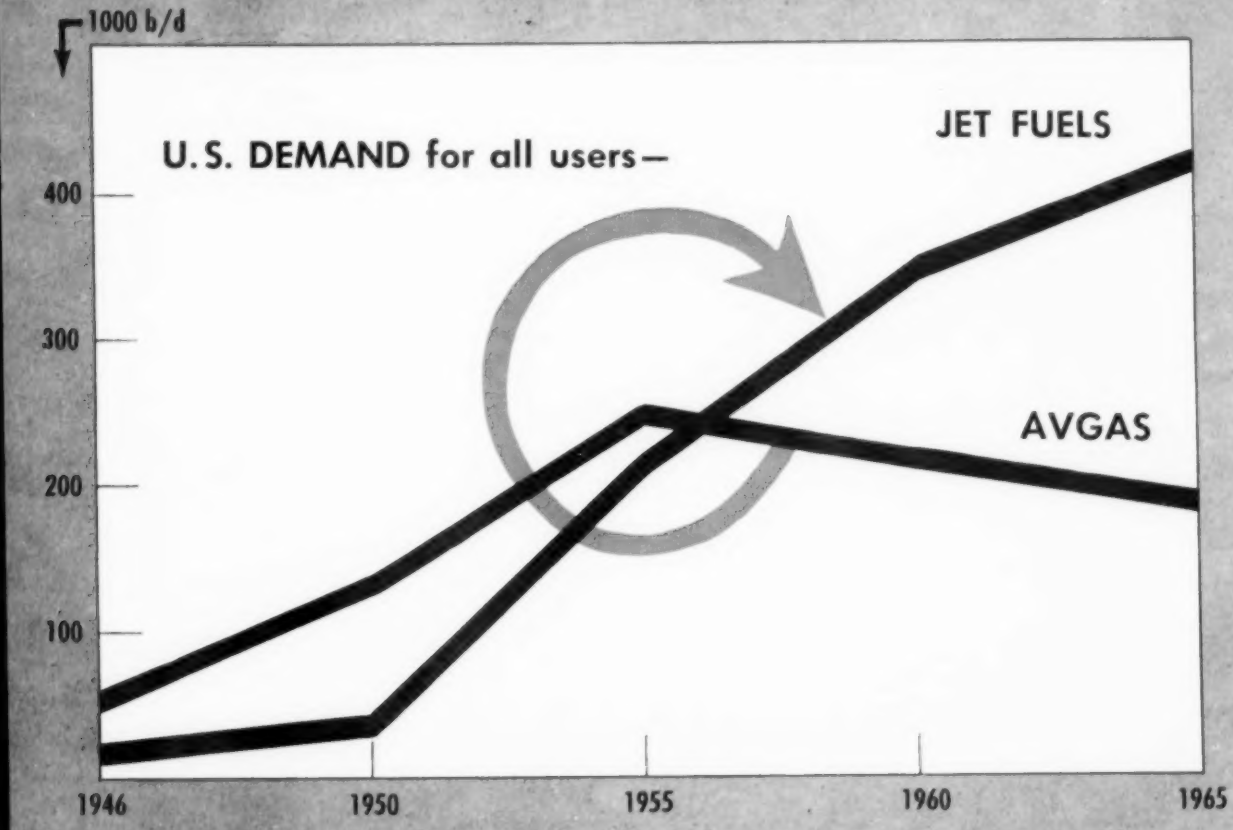
Petroleum Processing

PETROLEUM REFINING | PETROCHEMICAL MANUFACTURING | GAS LIQUIDS RECOVERY

FEBRUARY, 1956



THE SWITCH IS SOON—What will jet fuel demand mean to refiners? p. 43

BUSMAN OR OILMAN?—Some valuable tips for your next trip . . . . p. 53

IRON CURTAIN LINGO—Technical Russian is not hard to learn . . . . . p. 55

TRAY DESIGN BASICS—Beginning a new design manual you'll keep . p. 64

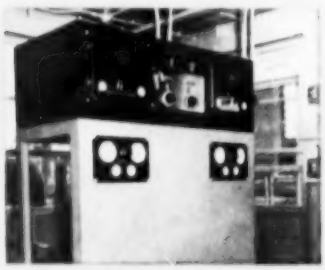
PRICE 35 CENTS

A McGRAW-HILL PUBLICATION

TECHNICAL DATA

The Sinclair Refining Company's Plant in Hartford, Illinois is equipped with the Proportioneers TC-CRP, Type 500-45 Two Component Blender. It produces up to 500 barrels per hour of various asphalt cutbacks. The stream blender is arranged to blend an asphalt and diluent in a given predetermined ratio ranging from 90% asphalt and 10% diluent to 55% asphalt and 45% diluent. The diluents are naphtha for RC cutbacks and kerosene and distillates for MC and SC cutbacks. This system has a recirculation feature on each stream to allow a test run of the blender setting before actually blending products. It also has a Tally meter for presetting the required number of barrels needed in a batch and when the required batch is blended, the two streams return to recirculation.

Asphalt cutback stream blending at Sinclair Refining Company, Hartford, Illinois.



Close-up view of Model TC-CRP unit in control house shown above.

The stream blender uses positive displacement meters for measuring the two base products and the blended product. The meters give exceptionally high accuracy and very fine control over the entire range of asphalt cutbacks.

The system is equipped with remote stop and start positions at both tank truck and tank car loading racks. This feature makes it possible for one man to operate the blending plant and to do all the required loading.

"STREAM BLEND" ASPHALTS FOR STREAMLINED HIGHWAYS

THE PROBLEM:

Manufacturers of road oils and asphalt cutbacks recognize the blending of asphalt and cutter stock in open or vented tanks as a potential fire hazard. The present method of batch mixing an RC cutback by the addition of cold naphtha to hot asphalt results in high evaporation losses . . . while subsequent mechanical agitation produces an end product which requires reblending to produce the desired end viscosity. Material and time losses result. This is also true in MC and SC production, but to a lesser extent. The number of reblends required to produce the end viscosity depends entirely on the skill and experience of the operator.

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Continuous, automatic in-line blending of asphalt and cutter stock . . . with after-cooling where necessary . . . produces a stable end product of predetermined viscosity in a single pass . . . directly to mobile equipment. This system eliminates any fire hazard . . . loss of time and materials . . . and the need for redoping and subsequent mixing. It also cleans up the operation, increases efficiency, and assures economical operation. A single operator . . . with stream blending . . . can reproduce any blend required by the adjustment of one master ratio control.

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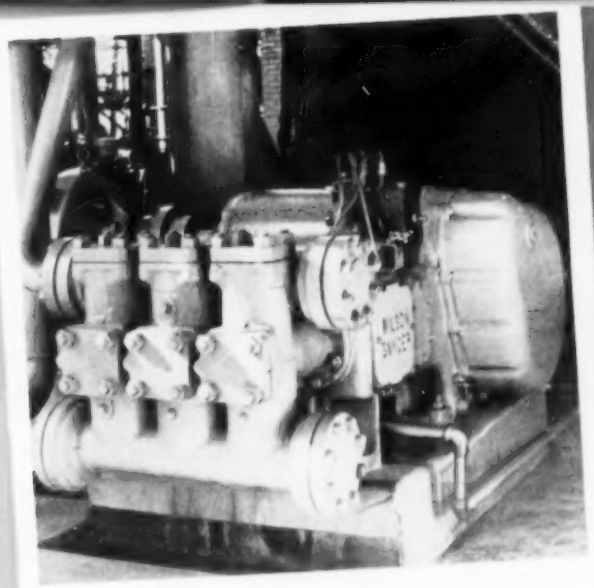
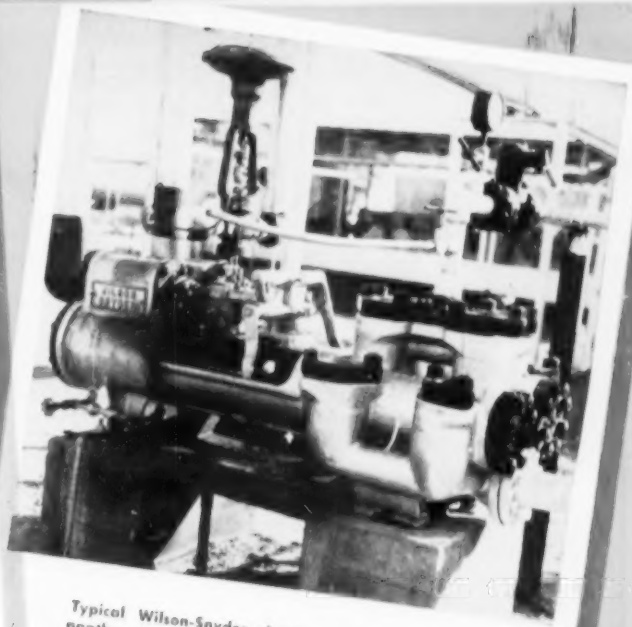


Typical Wilson-Snyder triplex plunger power pump in Universal Oil Products Platforming reactor charge service.



Typical Wilson-Snyder duplex steam pump handling naptha charge in an Atlantic Catforming installation.

Wilson-Snyder Reciprocating Pumps
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RECIPROCATING pumps offer many money-saving advantages over multistage centrifugals from 20 to 200 gpm when the differential head in feet is over 20 times the gpm.

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Reader's Guide What's New in Petroleum

The Airlines Are Going 'Jet'

What will this mean to refiners? Operation "big switch" is coming fast. Probably in another year, jet fuel demand will soar past regular avgas. Then, it'll keep climbing while avgas drops off. How much jet fuel will we need? By V. B. Guthrie. **p. 43**

I 1 2 3 5

How Sohio Makes Ammonia

. . . and its derivatives. Here's a thorough-going description of the new Lima, Ohio, plant, whose products also include nitric acid, nitrogen solutions, dry ice, and urea in the first unit in this country to use the Inventa process. **p. 46**

II 2 3 4

Beat This Lab Safety Record!

Indiana Standard's Whiting, Ind., laboratories has broken all existing records with no lost-time injuries in 7.5-million man-hours of work – and the record is still climbing. Cooperation was the key to the big pay-off, says James E. Friden. **p. 51**

I II III 1 5

How to Take a Busman's Holiday

Play "busman" on your next trip away from the job. Visit another plant or a lab and exchange ideas with others in your field. S. D. Boynton tips you off on making contacts, planning the trip, and following up after you get back. **p. 53**

I II III 1 2 3 4 5

Русский медведь говорит о своей работе

The line above means "Russian Bear Talks Shop," says Marshall Sittig, who then explains how simple it really is to learn technical Russian and profit from the information available here right now. **p. 55**

I II III 1 2 3 4 5

Biggest Boost in LPG since 1922

Sales in 1955 rose 17.2% over those in 1954. This was sparked by big upswings in the use of LPG by manufacturers of petrochemicals and synthetic rubber. Here's a rundown and analysis of the shifts and changes that are taking place. **p. 60**

I II III 3 5

Water and Wheels

That's what it took to move this giant reactor vessel for a new catalytic reforming unit some 8000 miles from the Netherlands to its final destination at Ras Tanura in Saudi Arabia. Here's a fast glimpse of that trip in words and pictures. **p. 62**

I 2 4

Getting All You Have Coming?

There's something "extra" in our newly revised Readers' Service Cards. We hope you've started using it. If you haven't, the cards now include a handy order form for telling us what reprints you want, plus a list to help you choose. **p. 123**

I II III 1 2 3 4 5

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Processing for February, 1956

Starting this Month

New Process Design Methods for Optimum Bubble-Cap Tray Design

The first truly complete process design manual for logical selection of every bubble-cap and tray factor. This four-part series has a number of "firsts." Prepared exclusively for you, by W. L. Bolles, Monsanto Chemical Co.

- Determining optimum bubble-cap design
- Finding optimum cap size and spacing
- Proposal for standard bubble-caps
- New techniques for optimum tray design
- Simple, reliable estimation of pressure drop and liquid gradient

Part I starts on . . . . . p. 64

And then Next Month . . .

More on Tray Design

In the second installment of his four-part series of articles on bubble cap tray design, author Bolles will discuss every factor involved in the process design of this equipment.

His second article will include such essential factors as: construction materials, general types of trays, downcomers, weirs, cap pitch, spacing, the height of the skirts, and so on.

Don't miss it — your March issue!

Coming Next Month . . .

Another special editorial report, 32 pages on:

Heat Exchangers

This is an extra – you will also get your usual diet of feature articles, departments, and other editorial fare. Designed as permanent reference information for you, it will cover the following:

- Definition and use of heat exchangers
- Types of construction
- Process design and mechanical design
- Which processes require heat exchangers
- Installation, operation, and maintenance
- How much each type of exchanger costs

Next month — Watch for it!

DEPARTMENTS

Publishers Page	7	Patents	107
What's Happening	9	Suppliers	113
Tomorrow	11	Meetings	113
Process Data Sheet	89	Books	117
Plant Practices	92	Information Offered	120
Operating Trends	97	Advertisers' Index	132
Engineering Data Sheet	101	Readers Service Card	133
Personals	102	What's New	135
New Words	104	Editorials	156

Continue "Readers' Guide" on p. 85

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —THE EDITORS

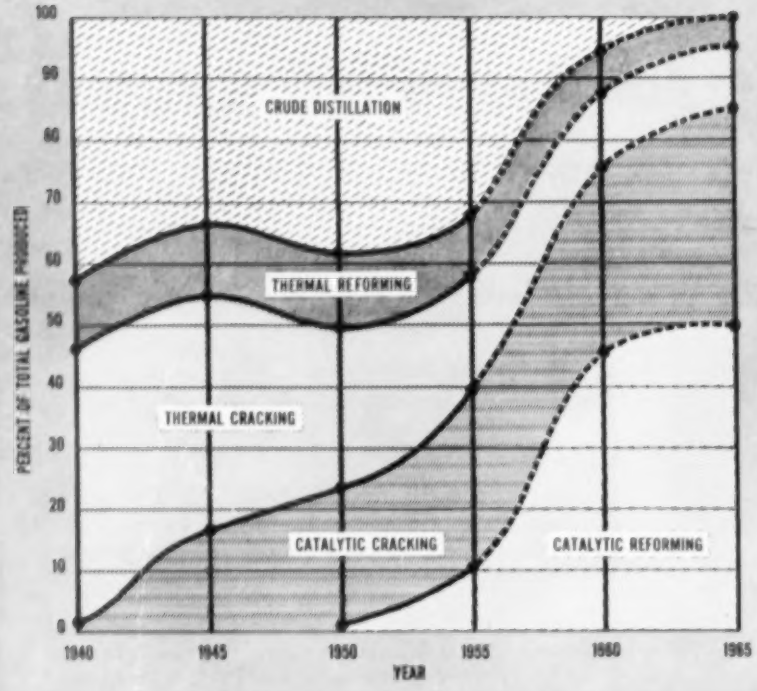

FIG. 1. Trends in processes for making gasoline. By 1965 catalytic reforming may account for 50% of all gasoline.

How to get your top octanes more economically

By HAROLD J. GIBSON
Ethyl Corporation, Detroit, Michigan

WITH the growing trend to better-grade gasolines, the cost of producing those last few octane numbers has steadily increased. As a result, refiners are looking anxiously for more economical ways to get their top octanes.

Already octane numbers in the 97 to 98 range are being marketed in the East and Southwest. And the trends for all U.S. refineries in terms of pool, regular and premium fuels show that octane numbers are continuing a slow, steady rise each year.

To meet the demand for higher-octane fuels, refiners are being constantly forced to change their processes. A look at the graph at the top of the page (Fig.1) will show you the gradual changes in process evolution. Note that by 1965 catalytic reforming may account for 50% of the total gasoline production in the industry.

Depending on the specific octane-improvement problem, the economic answer usually consists of a combination of tetraethyllead and various processing steps. (Some of these processing alternatives are displayed in Fig. 2.) The question becomes: How to determine the most economical way to get those top octanes. Only by conducting a detailed economic analysis can a refiner be sure of finding the best solution for his refinery, for from an economic analysis he can determine the proper balance between lead and a processing alternative.

An economic analysis will take into consideration all of the factors that affect the costs of making your gasoline: for example, optimum rates and yields, raw-material costs, product prices, operating manpower, maintenance and repair, utilities, depreciation, investment charges and reasonable "pay out."

TABLE 1. Estimated Pool Octanes and Premium — Regular Octane Numbers

		With 2.2 ml gal TETRAETHYLLEAD	With 3.0 ml gal TETRAETHYLLEAD
At the end of 1953	Pool	88.0	89.4
	Premium	92.9	94.3
	Regular	85.9	87.3
At the end of 1954	Pool	89.3	90.7
	Premium	94.2	95.6
	Regular	87.2	88.6
At the end of 1955	Pool	90.8	92.1
	Premium	95.7	97.0
	Regular	88.7	90.0

Octane improvement analyzed

From such an analysis you can determine the economics of octane improvement, which is the tool for obtaining the optimum sequence of processing steps and attendant use of tetraethyllead. Analyzing octane improvement costs calls for a thorough understanding of unit operating costs, particularly when incremental expenses are being considered.

There are several approaches for analyzing the costs of octane improvement at higher levels. At Ethyl we have found, through our studies of the economics of top octanes, that the key to cost analysis is a value called *incremental cost*. Simply expressed, this is the rate at which costs increase as you raise the octane number. It can be expressed conven-

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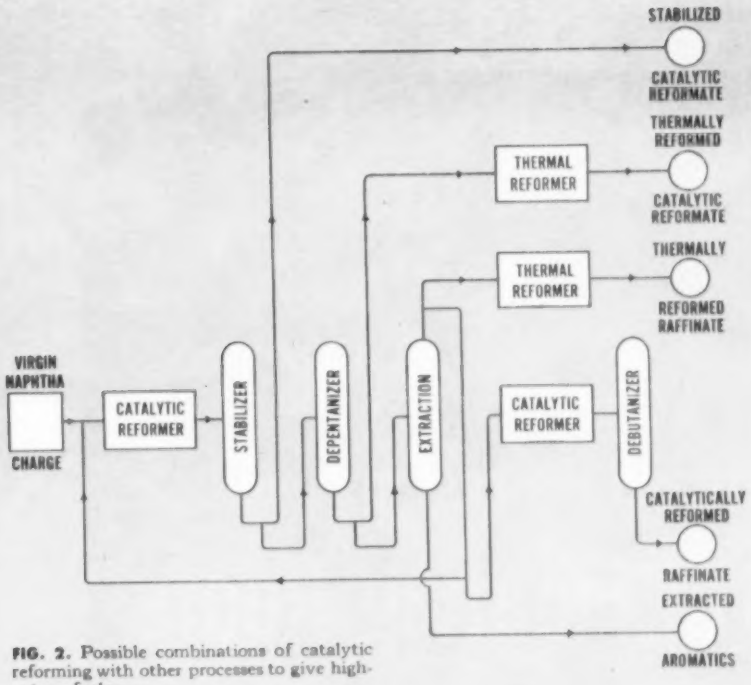

FIG. 2. Possible combinations of catalytic reforming with other processes to give high-octane fuels.

iently in cents per Research octane number per barrel. (¢/RONB).

Once you determine incremental costs, the next step is to make sure you are employing the best possible process at each point. By plotting the cost curves on a chart, you will see that up to a point the cheapest way to improve gasoline is with lead. Then lead becomes closely competitive with mild reforming methods.

After you reach an incremental cost of about 5¢/RONB, it again is definitely cheaper to add tetraethyllead. And finally when the full 3 cc of lead is used, you must return to reforming—this time at greater severity.

Today there's a greater trend toward using lead in higher concentrations for, as one industry spokesman put it, "tetraethyllead has decreased steadily in price while the costs of refinery construction have continued to rise rather sharply."

With constantly increasing gasoline-quality demands facing the refiner, it has become increasingly important to define the optimum route to high-octane fuels. Lead addition now costs an average of 4 to 5 cents per Research octane number per barrel, and this is directly competitive with the cost of mild reforming operations for octane improvement. As product octane levels increase, refiners may have the choice of using maximum tetraethyllead—3 ml/gal—or going to more expensive reforming operations—more severe single pass reforming or extraction followed by raffinate reforming. Here—even though lead susceptibility decreases somewhat in aromatic reformates—the cost of octane improvement by lead becomes increasingly more attractive as compared with various processing alternatives. Where extremely high octane levels are required, a refiner has little choice but to use the more economic tetraethyllead to the maximum and then to vary his processing alternatives to give the desired product quality if he wants to hold his manufacturing costs to a minimum.

KNOW THIS EQUATION?

$$¢/RONB = \frac{(Y-100-F)(Pg-9.4T) + Pb(E+G) + Pf100H - 100E}{100\,RONp - 100\,RONn - 10F + Y(RONr - RONp)}$$

You should if you are making an economic analysis. Write for a copy of a recent 50-page report giving a definition of terms of this equation and other information on new processing alternatives and on the economics of top octanes. Address your request to Department No. 23, Ethyl Corporation, 100 Park Avenue, New York, New York. No charge.

HOW Ethyl Research can help you

Our Refinery Technology staff, backed up by the extensive facilities of the Ethyl Laboratories, will be glad to share their experience with your economics people when you conduct a cost analysis of your top octanes.

We will work with you, or if you prefer, we are even equipped to do a complete cost analysis for you.

We can help you answer these and other questions: When should you use "Ethyl" antiknock compound in preference to increasing the catalytic reformer charge rate? How does increased severity of reforming affect your costs? When should you carry your tetraethyllead content to the maximum allowable—and under what circumstances?

Your Ethyl Representative will be happy to arrange an appointment for you with one of our Refinery technologists.

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(To obtain more data on advertised products see page 122)

Petroleum Processing

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Publisher's Page

Something New's Been Added to Texas

THERE's a new face on PETROLEUM PROCESSING's editorial staff. It belongs to Ronald E. Cannon, who joined us Jan. 3 as our Southwestern Editor. He'll be in our Houston office, and replaces Dave Thornton, who left us to join U.O.P.

Ron is a native Texan, born over Beaumont-way. He finished high school in Baytown in 1943—and then enlisted in the Navy. He served overseas with the Seventh Fleet ("I was never shot at"), and was released to inactive duty in 1946 (Lt., j.g.).

Louisiana Polytechnic Institute claims him as an alumnus. He was graduated (cum laude) in 1948 with a B.S. in Mechanical Engineering. There's also some Tulane knowledge in his head, however; he started his college work there while in the Navy.

Since graduation, Ron's been in the Construction and Repair Department of Gulf Oil Corp. in its Port Arthur and Philadelphia refineries. For the past four years with Gulf he's been a Field-Project Engineer. "I served as Gulf's representative to the contractor, coordinating his efforts with Gulf's various departments. I personally inspected his work, supervised other inspectors assigned to the unit, and assumed responsibility for the correct installation of the work according to the contract and specifications." As an afterthought he added: "I also coordinated and directed the work of plant forces (except operators) in the start-up of completed units."

Ron is 30 years old, married, and has two children. His outside interests include golf, photography and dogs. (He's an avid devotee of the Pit-Bull-terrier). He's a Registered Professional Engineer in the State of Texas (No. 12254).

Our choice of Ron, who admits to being a complete novice as an editor, is a good example of the kind of men we want on our staff. When we look for a new editor, we look for an engineer with industry experience. We want a fellow who has worked in a plant or engineering office. We want one who talks your language, who knows what you think about, who's familiar with your day-to-day problems.

I figure we can take such a person, if he's inquisitive and smart, and teach him what he needs to know about editorial work—a lot easier than we can make an engineer out of a journalist.

You readers in the Southwest won't see much of Ron for the next few months. We'll be keeping him pretty busy on a training program. But he'll soon be calling on you, attending technical meetings with you, and writing helpful, informative articles for you.

William F. Bland

Editor

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National Petroleum News
The monthly magazine of oil marketing—news, prices, transportation, storage merchandising

Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago, Houston

Platt's Oilgram Price Service
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Petroleum Week
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What's Happening

in Refining

. . . **Shell Oil** has officially completed its Anacortes, Wash. refinery with the bringing on stream of its most advanced fluid cat cracking unit. Designed for a 23,000 b/d intake, the new unit is expected to provide very high-octane gasoline yields. Design capacity of the Anacortes plant is 50,000 b/d.

. . . **Esso Research Laboratories** will build and equip a new $1.5-million, three story lab building next to the company's main research facilities at Esso's Baton Rouge, La. refinery. Advanced X-ray, high speed computing, and radiation facilities will be provided for the 150-man staff. Completion is scheduled for early 1957.

. . . **Ethyl Corp.'s** octane survey shows nation-wide weighted average of premium rose in 10 months of 1955, regular, in eight. December averages of 96.1 for premium and 88.9 for regular were up 1.8 and 1.6 octane numbers, respectively, for December, 1954.

. . . **National Bureau of Standards** is planning to drop Saybolt viscometer master tubes as the measuring device for lube and fuel oil viscosity. NBS wants to standardize on kinematic viscometer readings converted to Saybolt values with ASTM tables. Bureau has arranged to hear objections to proposal.

. . . **ODM** has recently granted the following rapid tax write-offs:

. . . **Ashland Oil and Refining**—50,000 b/d crude fractionator and 20,000 b/d cat cracker at Cattlesburg, Ky., 65% on $4.15-million, 50% on $1.1-million, and 15% on $250,000.

. . . **Bankline Oil**—Reactivation of 800 b/d alkylation equipment at Bakersfield, Cal., 100% on $500,000.

. . . **Cooperative Refinery Assn.**—4,200 b/d cat reformer, 3,000 b/d hydrogenation unit, 8,000 b/d coking unit at Coffeyville, Kan., 65% on $3.912-million, 40% on $85,000, and 15% on $63,000.

. . . **D-X Sunray Oil**—expansion of cat cracker and gas recovery system at Tulsa, 65% on $828,000.

. . . **Pure Oil**—15,000 b/d cat reformer at Smiths Bluff, Tex., 65% on $4.535-million and 45% on $897,300.

. . . **Sunshine State Refineries**—10,000 b/d refinery at Tampa, Fla., 65% on 7.9-million, 45% on $1.775-million, and 15% on $75,000.

. . . **Texas City Refining**—Expansion of alkylation unit at Texas City, 100% on $1.085-million, and 50% on $100,000.

. . . **Corpus Christi Refining Co.** has temporarily shut down its 7,000 b/d Corpus Christi plant to improve and expand facilities. The $1.2-million program will bring the refinery back on stream by June 1 with a capacity of over 10,000 b/d. Among improvements will be a redesigned and expanded crude unit of 3,500 b/d capacity, two new 50,000 bbl crude tanks, two converted 55,000 bbl product tanks, a new loading dock, and added asphalt capacity. This last accounting for almost half of the expenditure.

. . . **United Refining's** Warren, Pa. neutral oil and wax filtering operations are getting back on stream after a recent fire at the refinery filter house. Fire and resultant explosion caused "very little loss of product".

. . . **API figures** show two new refining records reached with the turn of the new year. For the first time refinery crude runs crossed the 8-million b/d mark. In the same first week of the year, distillate fuel oil output reached an all-time high of 13.5-million bbl.

. . . **Socony Mobil** plans to add 10 cat reformers, four alkylation units, and three hydrogen desulfurizers to its refining facilities by 1958. Total building and improvement program cost: $226-million. $95-million will be spent this year, $67-million in 1957, remaining $6-million in 1958.

. . . **Frontier Refining** is bringing a 2,500 b/d Platformer and 3,000 b/d Unifiner on stream at its Cheyenne, Wyo. refinery. The units, being installed by Procon, are part of a $1.5-million program. (PP, March, 1955, p. 303.)

. . . **Northwestern Refining** has started using Canadian crude in its 8,000 b/d, St. Paul Park, Minn. refinery. Five new 80,000 bbl tanks provide additional storage for the Canadian oil.

. . . **Pontiac Eastern Corp.** has given Fluor the contract for its $18-million, 12,000 b/d refinery near Hattiesburg, Miss. Plant will process low-gravity Mississippi crudes, using Fluid Coking and Unifining. Other process units include vacuum distillation, Thermofor cat cracking, Platforming, sulfuric-acid alkylation, and electric desalting. Completion is scheduled for mid-1957.

New units new under construction

. . . **Sun Oil** is building a $1.2-million, 1,400 to 1,600 b/cd alkylation unit at its Toledo, O. refinery. Completion is scheduled for April.

. . . **Tide Water** has started three more units at its still-going-up 130,000 b/d refinery near Wilmington, Del.: a polymerization plant, a sulfur recovery plant, and a UOP catalytic desulfurizer.

Regional developments

. . . **Aviation Fuels, Inc.,** and **Sinclair** both plan activity on the Texas Gulf Coast. Aviation Fuels will build a $24-million refinery at Beaumont, and Sinclair will spend $16-million for expansion of its Houston refinery.

. . . **U. S. Oil and Refining,** and **General Petroleum Corp.** both have plans for Washington State. U.S. Oil and Refining will start a $10-million refinery at Tacoma, and General Petroleum will add $3.6-million in improvements at its Ferndale plant.

in Petrochemicals

. . . **B. F. Goodrich** calculates that synthetic rubber will account for about 62% of the 1.335-million tons of rubber of all types expected to be consumed in the U.S. this year.

. . . **Koppers** has been granted U.S. licensing rights to a German aromatic recovery process. Both hydrogenation, to remove sulfur compounds, and distillation to remove paraffinic compounds and purify finished benzene, toluene, and xylene, are used in new process.

. . . **Shell Chemical** will become the second oil company producing urea when its new 36,000 t/yr plant goes on stream at Ventura, Cal. this fall. The Montecatini process will be used, with the necessary ammonia and carbon dioxide coming from Shell's nearby ammonia plant. Sohio was the first oil company in the field. Its Lima, Ohio plant is scheduled to start shipments this month.

. . . **Phillips Chemical** is planning another substantial capacity boost for its rubber facilities at Borger, Tex. The company will add 27,300 t/yr in copolymer output to the previously announced 15% expansion, giving the plant a capacity of almost 100,000 t/yr. A 24,000 t/yr capacity boost is scheduled for Phillips' adjacent butadiene plant. Goal there is also about 100,000 t/yr.

. . . **Columbia-Southern Chemical** will extensively expand research and development work at its Barberton, Ohio laboratories. The company's perchlorethylene processes were developed there.

. . . **Grace Chemical** is expected to build its $18-million polyethylene plant somewhere in the Gulf Coast area. An option on a site near Baton Rouge, La. has been taken and others, both in that area and elsewhere, are being considered.

. . . **Escambia Bay Chemical** has awarded Blaw-Knox the contract for its 15,000 t/yr polyvinyl chloride plant scheduled to go up near Pensacola, Fla., site of Escambia's still-in-construction, $23-million ammonia plant.

Petrochemical briefs

. . . **Northwest Nitro-Chemicals** plans to build a $22-million fertilizer plant in Medicine Hat, Alberta.

. . . **Petroleum Chemicals** will spend $4.4-million on expansion of its Lakes Charles, La. butadiene plant.

. . . **The Texas Co.** is planning a 300 t/d ammonia plant somewhere in the Gulf area, possibly Louisiana.

in Foreign Operations

LATIN AMERICAN NOTES . . . Pemex has set output of its refinery at Poza Rica, Mexico, at 10,000 b/d minimum. The new cat crackers are scheduled for installation by the Mexican oil monopoly at its Salamanca and Atzcapotzalco refineries . . . **Empresa Petrolera Fiscal,** the Peruvian government's oil organization, is about to bring its Villar refinery on stream. Now rated at 1,500 b/d, this plant was dismantled and brought up the Amazon from its original site at Zorritos in a $1-million operation.

EUROPEAN NOTES . . . British Petroleum has started construction of a Platformer at its Marghera, Italy refinery. Completion is scheduled for later this year . . . **Greece** will soon have its first refinery. The German affiliate of Hydrocarbon research has started construction of a 30,000 b/d plant at Aspropyrgos. Completion is set for early 1958 . . . **Yugoslavia's** fourth refinery, now going up near Makaraska, will process Dalmatian crude . . . **Petrofina** will start up, modernize, and expand the 2,000 b/d Muelheim refinery which went off stream in mid-1954. . . . **Hungary** is planning to expand its synthetic rubber industry later this year . . . **French** refinery throughput reached 15.6-million b/yr in 1955, up about 607,000 bbl from 1954, slightly less than the preceding annual increases. French refining capacity is about 16.8-million b/yr.

In Petrochemicals . . . ANIC, the petrochemical affiliate of Italy's oil monopoly, ENI, is building a $45-million plant at Ravenna to produce 175,000 t/yr of ammonia, and 38,000 t/yr of synthetic rubber. Completion is scheduled for 1957.

UK NOTES . . . British Petroleum's 6,000 b/d Platformer recently went on stream at the company's Llandarcy, South Wales, refinery. Twenty new storage tanks and a new coastal jetty are other recent additions. Improvements are part of a $1.5-million program. One of BP's UOP Platformers is producing what is believed to be the highest-octane blending component yet obtained from low-naphthene Kuwait crude.

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This is just one inspection of extrusion dies through which a cast billet heated to a rigidly controlled temperature is hot extruded into a "tube shell" . . . from which Scovill Heat Exchanger Tube is subsequently cold-drawn.

One of the most highly skilled and critical jobs in the process is that of finishing and maintaining these dies. The smooth, clean surfaces of resulting shells are essential assurance of highest quality in finished tubes.

It is needless to tell Scovill customers that, while *correct alloy selection* is important to efficient exchanger operation, of equal importance is the *uniformity and soundness of tubes* themselves. Scovill Technical Service and tube production methods, considered by many the very best in the industry, can give you complete assurance on both these essential counts.

Scovill Heat Exchanger Tube is available in a comprehensive range of standard alloys (listed below).

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Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze 5% • Duplex Tube

19C54

Claim is for "92-plus" research clear gasoline reformate. Standard R-5 UOP Platforming catalyst is used.

In Petrochemicals . . . Over half of the increase in British plastic production last year was the result of increased output of polyethylene and polyvinyl chloride. **ICI** expects its maximum production of 35,000 tons of polyethylene this year to rise to 57,000 tons in 1957. Production of PVC in the company's Hillhouse plant will be doubled in 1957 from its present 30,000 t/yr figure. **British Geon's** new polyvinyl chloride plant, about to go on stream, will raise Geon's PVC output from 15,000 to 27,000 t/yr.

MIDDLE EAST and AFRICAN NOTES . . . Syria has decided that the long planned refineries originally to be located at Homs will instead be built at Tadmor . . . **Purfina** (Cia. de Combustiveis do Lobito), a Petrofina affiliate, will build a 20,000 b/d refinery in Angola. Completion is scheduled for late 1957.

FAR EAST NOTES . . . Mitubishi Oil is planning another Platformer—3,000 b/d capacity, and a 750 b/d Udex aromatic recovery unit for its 27,000 b/d Kawasaki refinery . . . **Idemitsu Kosan's** 20-30,000 b/d refinery will be built at Tokuyama, Japan, near Honshu's southern tip. Financing arrangements for the $17.5-million plant, which will use crude from several American majors, are almost complete . . . **India** will start building its first coal-to-oil plant in the Bengal Bihar region probably in 1957. Capacity of the $100-million plant will be 300,000 t/yr . . . **Shell** and **Standard Vacuum** are planning to build refineries in the Philippines. The British Shell plant will be the largest single postwar investment by a non-American firm. Stanvac's plant will cost $35-million and have a 21,000 b/d capacity.

In Petrochemicals . . . Furukawa Chemical Industry Co., a new firm formed by the eight-company Furukawa financial combine, will enter petrochemicals with the help of three B. F. Goodrich affiliates. First three projects will be: an $8.3-million synthetic rubber plant near Tokyo; a $2.8-million polyethylene and ethylene oxide plant at Ogu; and an $8.3-million synthetic wool plant at Niigata.

in Transition

. . . **Empire Petroleum Co.** of Denver, Colo. has completed its merger with Wisconsin Oil Refining Co., Sheboygan, Wisc. Empire, the surviving firm, reports that the 5,000 b/d Sheboygan refinery, down since late 1955, will go back on stream this month with substantial new equipment. The plant, now the only Wisconsin refinery making road oils and asphalts, will have facilities for production of all grades of these products. The company's Denver plant will also be expanded.

. . . **Socony Mobil** and **Houdry** Process have settled their litigation over certain cat cracking processes. The amicable settlement calls for exchange of full immunities in the moving-bed cat cracking field for both themselves and their licensees. Each company also may pass on know-how received prior to 1956.

Also, the two companies will grant to each other and any present or future licensees an irrevocable nonexclusive royalty-free immunity under patent rights for certain cat cracking moving bed inventions made in the five years just prior to 1956.

In acquisition of certain patent rights and in settlement of patent claims, Socony Mobil will pay $3-million to Houdry in addition to $12.50 per barrel of licensed capacity for each paid-up license, and 0.75¢ per barrel out of running royalties received, until such payments amount to $12.50 per daily barrel of capacity during the next five years for all new TCC licenses.

in Markets and Prices

. . . **The industry's fuel oil branch** started in 1956 riding the crest of the wave. Demand for both distillate fuels and residuals remained high, and prices advanced over a broad front in both primary and secondary supply markets. Even gasoline, the "off-season" product, was faring well—if there was concern over mounting inventories, it wasn't reflected in refiners' offerings at reduced prices.

Early in September, inventories of kerosine and distillate fuels (combined) were 10.1% higher than a year earlier. By mid-January, this disparity had faded completely. And still primary suppliers were hard pressed to meet the demands of regular-customer accounts.

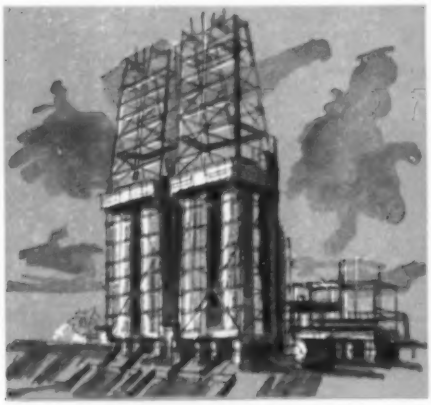
There was a general 0.3¢/gal increase in distillate fuel prices along the East coast, northward from South Carolina. In the Midwest, prices rose 0.5¢/gal generally. Group 3 prices were up 0.25¢ to 10¢/gal for kerosine and 9¢ for No. 2 fuel. Propane prices rose 0.5¢/gal, with Group 3 contract postings at 4.5¢.

. . . **On heavy ends,** prices were firm to higher. Oklahoma No. 6 fuel was up another 5¢, to $1.95/bbl. Scarcity of supplies in the Midwest was such that several refiners were supplementing their own production with uneconomic tank car hauls from the Gulf Coast.

Residuals also were tight in other markets. East Coast suppliers limited their offerings to contract customers. And on the West Coast, at least two refiners were buyers of residual—last summer the West Coast supplied large quantities to the East Coast.

. . . **Good news for the refiner** was the announcement from Armed Services Petroleum Purchasing Agency of its jet fuel needs during the period April-September 1956 (off season for distillates.) The military wants 39.2-million bbl, 22% more than in the similar 1955 period.

Lummus Coker for Yorktown Refinery Will Handle Heaviest Charge on Record



The Delayed Coking Unit for the new Yorktown, Virginia refinery of The American Oil Company will handle the heaviest feed ever charged to a Delayed Coker. The Lummus Company has been selected to design and construct the unit. Special techniques have been developed in Lummus laboratories and pilot plants to handle such heavy stocks.

Charge to the Unit will be vacuum reduced crude which will have 25.0% Conradson Carbon and an API gravity of 6.1°. SFS at 210° F is 6000. The products will be gas oil, gasoline, gas and C4's, plus 600 tons per day of coke. The Unit is also designed to handle lighter stocks at a maximum capacity of 9,660 B/D.

The Coking Unit will have four coke drums. The Lummus Heater, which is the heart of this process, incorporates the critical design factors to meet the wide range of charge stocks and throughputs.

The new coker will come on-stream late in 1956. As an integrated part of the Yorktown Refinery, it will help supply motorists' demand for more of the American Oil Company's premium unleaded motor fuel, "Amoco-Gas," marketed in 18 states from Maine to Florida.

Lummus has designed, engineered and constructed a large percentage of this country's modern coking capacity. Lummus can build a coker . . . or a complete refinery . . . for you. Let Lummus engineers show you how 50 years experience with over 700 major installations will produce maximum return on your capital investment.

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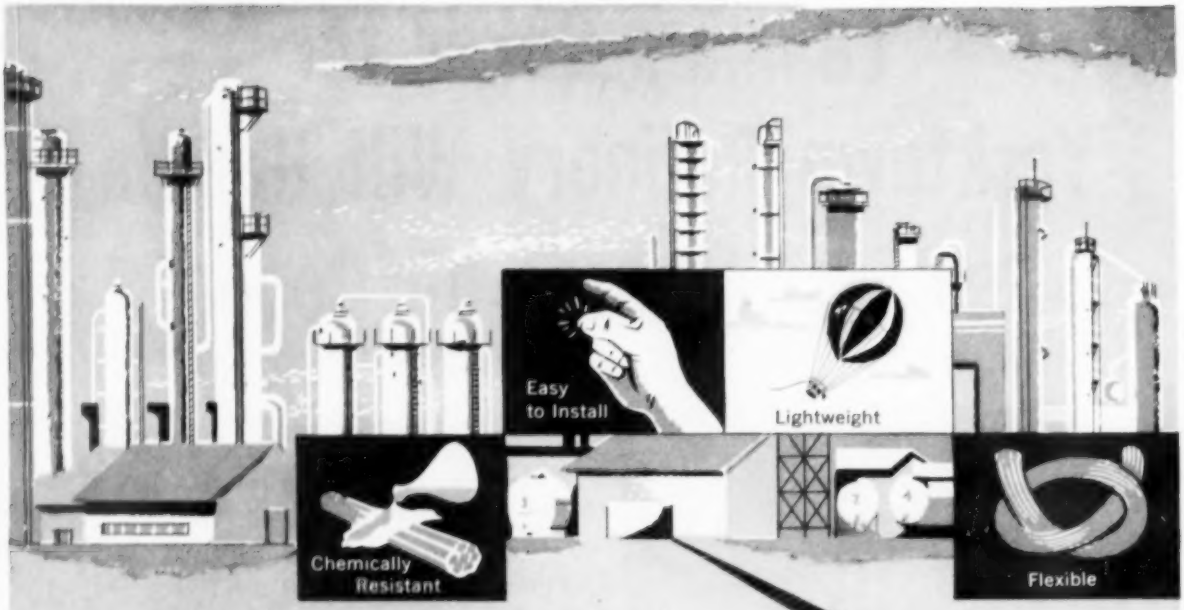

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AA-1007

Health of Oil Executives Getting More Attention by Management

CONDITIONS of job slavery, commonly associated with the early days of the industrial revolution, have of course disappeared from the scene. Today's employe, regardless of job level—workman, engineer, supervisor, researcher, or department head—turns in his share of the job to be done, and that's that. He has not sold his "soul" to the company. He is a free man. What he does on his own time is his business. This has been one of the strengths in the rapid progress of the private enterprise system—respect for the dignity of the individual.

There is one area, however, in a man's private life which has been getting an increased amount of attention. And that is the matter of health. Too many dollars are at stake for oil companies to risk a loss in efficiency of executives that might stem from illness.

A growing number of oil firms are setting up health programs. Typical of such programs is one being carried out by Socony Mobil Oil Co.* Headed by a medical department at the home office under a medical director, the operation includes in-plant facilities at 23 locations in the U.S. and many overseas, using 58 full-time doctors and 59 nurses, plus about 500 consulting physicians.

Big aim of the program is preventive medicine, to try to develop sound living and health habits in men as they are rising in their business careers. Dr. G. M. Saunders, head of Socony's medical department and also chairman of the American Petroleum Institute's Medical Advisory Committee, points out that much can be done to lessen the effects of illness on the present, older executives.

But, he observes, "The benefits that accumulate over the years will be most apparent among the managers of the future."

Key to the program is regular, periodic examinations and counseling by a physician, but confidential and usually non-compulsory.

Typical functional and organic problems are a large part of the problem of today's executive—and this includes high blood pressure, heart trouble, cancer, diabetes, stomach diseases, and the like.

Big target of medical programs, however, is nervous disorders. These are proving to be the biggest thieves of operating efficiency on the job. Dr. Saunders says these range from minor anxieties and insomnia to serious obsessions.

Just plain hard work alone is not hurting anyone; the big factor is worry. "If a man likes his work and doesn't worry about it, he can take his briefcase home at night or on the weekend," explains Dr. Saunders.

Ambitious though the Socony program may appear, the company is planning to expand it further, with more in-plant facilities in districts where they are still lacking.

While this represents a program in one of the bigger major oil companies, many smaller firms can do and are doing things for the health of their managers. They can call on outside physicians and on a number of organizations, such as the American Medical Assn., Industrial Hygiene Foundation, U.S. Public Health Service, university medical departments, and life insurance companies. —W.C.U.

* "Management Health Is an Important Factor in Oil Industry Planning," *Petroleum Week*, Jan. 6, 1956, pp. 24-25.

Tomorrow's Ideas Here Today At Philadelphia's "Chem Show"

"PICTURES at an Exhibition" is the title of a piece of classical music. Phrased another and somewhat more apt way, "pictures of tomorrow's equipment today," it was in many ways the theme of the biannual Chemical Exposition in December in Philadelphia's Convention Hall.

For any petroleum processing industries engineer seeking significant trends in designs and ideas, the 1955 show was by far one of the best in recent years. Among highlights of particular interest were these three:

- A new method for coating metal with a protective covering of plastic.
- A gas analyzer operating on the principle of radio frequency.
- A new, integrated process control system.

The new plastic coating process was actually a slight variation of a technique imported from Germany. The plastics used so far have been nylon and polyethylene. Thus far, only relatively small objects such as laboratory ware have been coated. However, as soon as larger coating equipment is built, larger objects such as full-scale production equipment can be handled.

Operating principle of the technique is fluidizing. The metal object—for example, valves, fittings, pump impellers, and other irregular shapes—is first preheated. It is then dipped into a fluidized bed of the plastic (which is in powdered form). The object is removed from the bed after 10 to 15 secs. and returned to an oven for curing. A uniform coating up to 3/16 in. thick results.

Advantages cited for the process is that coating can be done in 50% of the time needed for spray coating, previously the only way such corrosion-resistant materials could be applied. In addition, no flux is required: the metal is heated and then coated directly.

The new radio frequency gas analyzer is not yet available, though it is expected to be sometime during the first part of 1956. Based on a new principle of mass spectrometry, it uses radio frequencies rather than a magnetic field to determine selectively the molecular mass of an unknown gas.

Through a series of plates, impressed successively with a selected radio frequency, the molecular masses are propelled. Those molecules which manage to pass

through a barrier imposed by these radio frequencies are collected on a terminal plate. A "leakage" dial indicates the mass peak, thus identifying the selected gases.

A new scanning and logging system was shown for the first time as an integrated unit. Basically, it is a combination of existing instrument components in a compact unit, including a graphic control panel. Up to 100 process variables are scanned, and then logged on an automatic typewriter.

Systems of this type are not entirely new. However, this particular system incorporated means for pre-setting the order of logging to almost any arrangement, merely by replugging connections on an integral point relay board. Illuminated signals on the graphic panel provide identification of the corresponding recorder or controller in operation at any specific time point. W.A.B. & W.C.U.

Neutron Irradiation Gives Clue To New Types of Catalysts

TO date, most published material on atomic energy as a processing tool has dealt with the direct conversion of petroleum and petrochemical materials. Now the Socony Mobil Oil Co. laboratories have announced that neutron irradiation can make catalysts out of otherwise inert material.(1)

Catalytically inert pure silica gel was irradiated with a total integrated (nvt) flux of $7.5 \times 10^{20} cm^{-2}$ fast neutrons and an equal magnitude of slow neutrons. Another sample was exposed to one-fourth this flux.

Catalyst activity tests on the irradiated samples, as well as non-irradiated control samples, were made using n-hexane-1. Mass spectrophotometer analyses showed significant deviations for patterns passed over the bombarded silica gel, though no skeletal isomerization was found to have occurred.

Conclusions were that the irradiation increased silica gel's catalytic activity for the double-bond isomerization of the n-hexane-1.

The induced catalytic activity is thought to be due to lattice dislocations.

It is too early to evaluate the future impact of "induced" catalytic activity on catalytic processing, but the possibilities are vast. By the controlled combination of "natural" and "artificial" catalysts, the petroleum processor could have a more exact tool for tailoring his catalysts for specific feed stocks and desired products. —R.L.D.

(1) Weisz, P. B., and E. W. Swegler (Socony-Vacuum Labs.), "Catalytic Activity Induced by Neutron Irradiation of Inert Silica," *Journal of Chemistry and Physics*, Sept. 1955, pp. 1567-68.

Isobutylene Can Rise If Tires Of All-Butyl Rubber Hit Road

FOR many years now, the best kind of material for inner tubes has been butyl rubber. Its superiority to natural has won for it a solid position. As a direct consequence, the makers and suppliers of isobutylene and isoprene have enjoyed a fairly stable market. Butyl is a polymer of these two.

Recently, however, the introduction of tube-less tires has made obvious inroads on the markets for butyl rubber. A fly in this ointment has been reports from some areas that tube-less tires aren't the overwhelming success they'd been expected to be. All this has only served to make the road for butyl a rocky one, full of detours and ups and downs.

Now comes exciting new information—a development on the horizon of an all-butyl tire with high wearing qualities. Butyl apparently has not been the easiest material in the world to turn into a tire. A prototype of such a tire, already in pilot plant production, has had road tests showing that:

1—It is far superior to any other synthetic or natural rubber tire in wearing quality, because its chemical composition provides high resistance to both abrasion and oxidation.

2—It has unusually soft riding properties, with little or no "cornering squeal."

3—It maintains the same air-holding, low-leak tendencies as butyl tubes.

Still further improvements in butyl may come from research now under way by Esso Research & Engineering Co., who announced last month that a new butyl rubber pilot plant is to be built at Baton Rouge, La.

Other butyl rubber studies are also under way at Armstrong Rubber Co.'s plant at West Haven, Conn. Both Esso and Armstrong are producing the butyl tires now under test.

Although a commercial butyl tire may be one or more years away, the improvements needed in the material are seen as quite possible of achievement. And when they are, it will mean a very good market outlet for butyl rubber raw materials.

There's a further plus too. A better butyl is highly applicable to use in mechanical goods, fabric coatings, and electrical insulation. For example, in one new 1956 model car, the Pontiac, there is an estimated 100 different applications for butyl, including shock absorbers, window seals, radiator hose, foot pedal covers, etc. —W.C. U.

Chromatography as a Technique In Separation Gets New Boost

CHROMATOGRAPHY, a relatively old idea in separation techniques, got a new boost last month when Gulf Oil Corp. announced it had perfected a laboratory technique based on gas-liquid partition chromatography.

The method separates gases and liquids whose boiling points are so close that conventional distillation does not provide the separation desired, or at least it requires too much time to attain it. Gulf's technique was also said to separate materials in quantities too small for distillation, permitting improvements in trace analysis.

No immediate application outside the analytical laboratory is seen for this chromatography improvement. However, it would seem to presage some further possibilities in full-scale processing, particularly in petrochemicals. —W.C.U.

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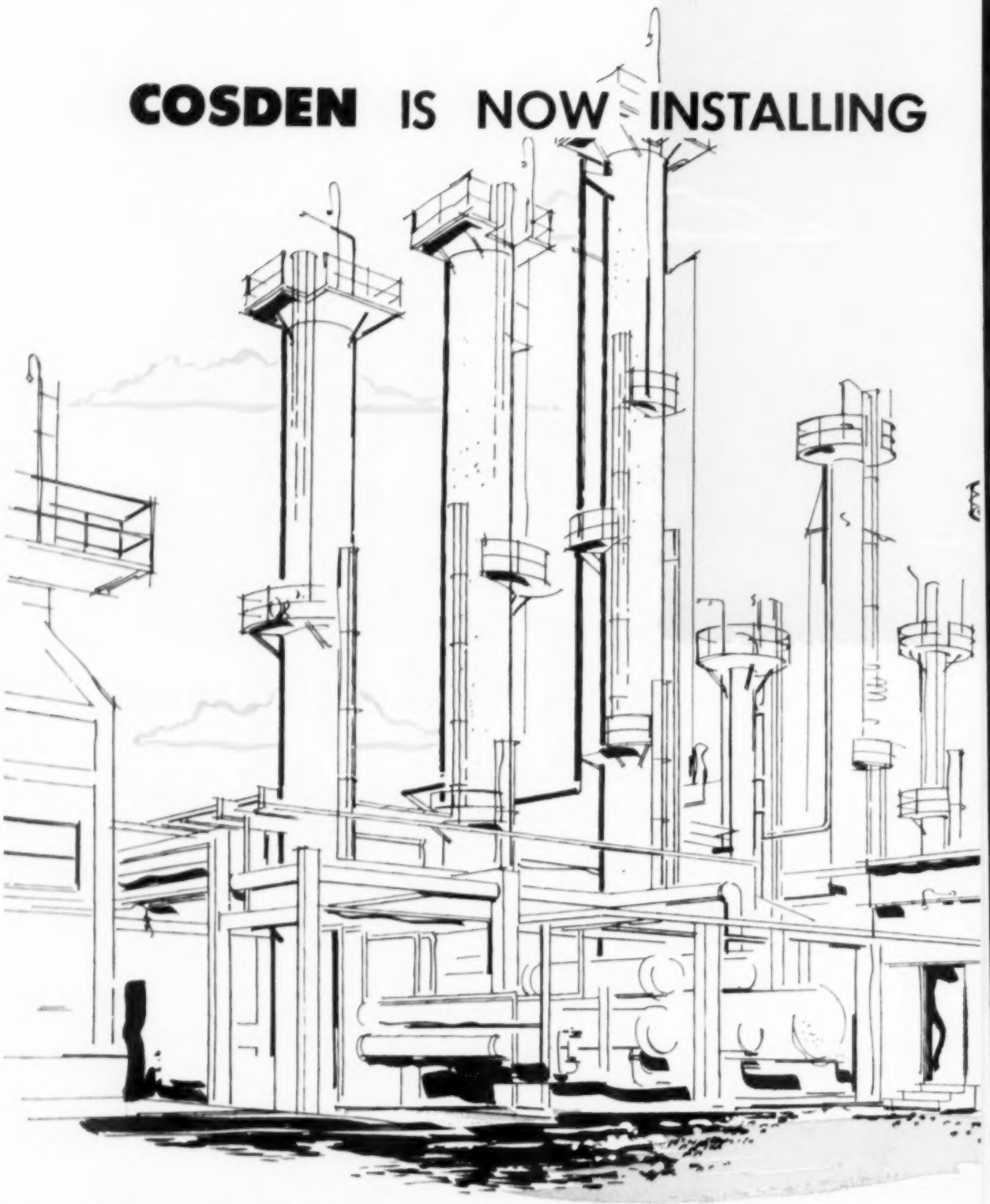

Rexforming

TRADE MARK

Always among the leaders in the production of highest quality petroleum products and petrochemicals, Cosden Petroleum Corporation is installing the UOP Rexforming process to keep pace with the growing requirements for better motor fuels.

The Rexforming process, capable of producing gasolines having octane ratings well in excess of 100, will enable Cosden to use its UOP Platforming unit, which now produces gasoline blending material, for continuous preparation of aromatic feed stock for a Udex unit.

Rexforming, the latest catalytic reforming process, was developed by Universal and is available to all refiners. The process enables refiners to produce the highest quality motor fuels to satisfy the demands not only of today's high compression automotive engines but also of still more powerful engines expected to be offered soon to the public.

UOP

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

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IF YOU'RE IN A HOLE OVER

THICKER AND BIGGER SHELLS . . .

Kellogg's Expanded Fabricating Facilities Can Help You Out

Why let shell geometry present a production bottleneck on urgently needed heat exchangers, towers, and other pressure vessels? M. W. Kellogg's expanded and complete fabricating facilities are geared to produce shells thicker, bigger, and in shorter time than ever before.

Production tools recently installed at Kellogg's New Jersey shop to meet increasing demands for larger vessels include: a planer capable of handling steel plate 40 feet long; huge bending rolls, augmented by a new, ancillary 2,000-ton press for bending plate up to 4 inches thick; and automatic welding equipment for longitudinal seams to 16 feet in length, and circular seams 12 feet in diameter.

In heat treating, Kellogg now can handle vessels larger than a railroad car, with thirteen furnaces having temperature ranges from 1200 to 1950 deg. F. Its pipe bending facilities can shape carbon steel and alloy piping 36 inches in diameter—to exceptionally close tolerances. In nondestructive testing, Kellogg's latest addition is its Kel-Ray* Projector. Using gamma rays, this unique instrument permits the radiographic inspection of welded seams 6 in. thick, 200 ft. circumference, in a single short exposure.

Backing up Kellogg's fabricating facilities are Kellogg engineers, who can either assume entire design responsibility or work closely with your own engineers; and Kellogg's staff of fabricating-welding engineers, who plan and administer a continuing personnel training program to qualify welders and mechanics on new techniques for fabricating new materials.

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PETROLEUM CHEMICALS DIVISION
NEWS

February ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

Want to get your TEL-handling people to think of safety "as a way of life"? Then you'll be interested in reading about the Du Pont Lead Hazard Clinic.

What makes a construction safety program, and what are the returns on a safety investment? To obtain a print of the movie that gives the answers, see the article on our film, "Builders of Tomorrow."

Who heads the Petroleum Chemicals Division Eastern Regional Lab? We'd like you to meet *Ed Jeffus*.

Have you heard about the oil industry's "best seller"? See the story about "Speak to the Earth."

THE DOLLARS AND CENTS OF SAFETY

New film of interest to refinery construction personnel

"The Builders of Tomorrow" is the title of a film about accidents that never happened. More importantly, it illustrates how and why they never happened.

This 28-minute color movie was made on location as the Du Pont Engineering and Construction Division erected the A.E.C.'s Savannah River Atomic Energy Plant in Aiken, S. C.

This plant, a 4½-year task, involves massive equipment, thousands of workers and many different hazards. It is one of the largest and safest construction undertakings in history.

In one period of over 6,000,000 work hours, not a single disabling injury occurred. The safety record achieved at Savannah River was 36 times better than the national average for this type of work.

Of interest to refiners

Many safety problems, similar to those encountered in the oil industry, were solved on this project. "The Builders of Tomorrow" should prove stimulating to engineers, supervisors and others concerned with construction safety. For this reason, the Du Pont Petroleum Chemicals Division has obtained prints of the film. Any sales office will be glad to arrange showings.

Du Pont Lead Hazard Clinic helps promote safe TEL handling through education

Because the dangers inherent in the use of tetraethyl lead are of a serious nature, the Du Pont Company, as supplier of this compound, offers refiners a program to help maintain safe handling operations. Originated in 1951, the program is called the Du Pont Lead Hazard Clinic. A review in January, 1956, showed that Du Pont had presented the clinic 280 times for 44 oil companies before a total audience of 7,787 persons.

Refinery personnel whose work brings them into proximity with TEL learn about the Du Pont Lead-in-Air Analyzer. Slides and booklets help make the Du Pont Lead Hazard Clinic easy to understand.

The clinic is available to all refiners. It is suitable as a refresher course for refinery, marketing, pipeline and terminal supervisory personnel and as a supplement to your own training courses.

Your problems discussed

The six sections of the clinic program cover the toxic properties of TEL, the source of TEL tank cleaning and repair hazards, safe cleaning practices, demonstration of the Du Pont Petroleum Chemicals Division Lead-in-Air Analyzer, a question and answer period, and a summation.

A way of life

Called "Something Else Is Necessary," the summation is delivered by the Petroleum Chemicals Division Medical Director. It emphasizes to the individual his own responsibility in

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED **Hazard Clinic**

achieving safe TEL handling . . . in making safety "a way of life."

Experience has shown that the question and answer period offers one especially important benefit to your employees. It gives them a chance to get detailed answers to particular problems from men with extensive experience in every facet of TEL handling.

Visual aids

In easy-to-remember form, a slide presentation shows graphically the safe procedures and recommended precautions for tank entry work. This part of the clinic program is followed by a 5-minute demonstration of the Du Pont Lead-in-Air Analyzer.

A booklet, "Tank Talk," recaps the clinic and a copy is given to each member of the audience. Over 20,000 copies have been distributed and the booklet is now in its third printing.

Available to all

In the interest of sound preventive medicine and good industrial safety practice, Du Pont makes this clinic available to all oil companies. It is recommended for supervisory personnel currently concerned with TEL handling procedures, and to others who may in the future be assigned to this area of operation. To keep their programs up to date, some refiners have set up repeat clinics on an every-other-year basis.

If you would like further information about the Du Pont Lead Hazard Clinic, consult your local Du Pont Petroleum Chemicals Division representative.

HEADS PETROLEUM CHEMICALS DIVISION EASTERN REGIONAL LAB

Ed Jeffus joined the Du Pont Petroleum Chemicals Division in 1950 and was appointed Eastern Regional Laboratory Manager in January 1952. As manager, he works closely with refiners and provides technical services which are directed toward the more efficient utilization of petroleum additives.

Prior to joining Du Pont, Jeffus was a chemist at the Shell Oil Company's refinery at Norco, Louisiana.

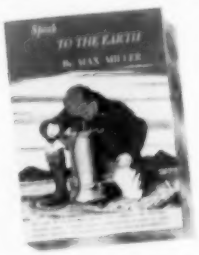
His entry into the petroleum industry followed schooling at Magnolia A. & M., Magnolia, Arkansas, M. I. T., and ending with a B. S. in chemistry at the University of Arkansas in 1948. During World War II, he was a meteorologist in the U. S. A. F. and served a 25-month overseas tour in England and France.

Originally from Texarkana, Arkansas, Ed now lives in Wilmington, Delaware with his wife and two children. His hobbies include hunting, fishing, skeet and bridge.

EDISON D. JEFFUS

Mr. Jeffus is a member of the American Chemical Society.

"Speak to the Earth" in Third Edition



Appleton-Century-Crofts, Inc., publishers, have announced a new printing for "Speak to the Earth," a book about the oil industry. The writing of this book was commissioned by the Du Pont Company.

The initial printing was a de luxe edition which was exclusively distributed by the Du Pont Petroleum Chemicals Division. At the same time, a standard edition was produced and marketed to the public by the publisher. This has been sold out.

Of the edition now in printing, 1500 copies will be used by the O.I.I.C. The remainder will be available through regular book stores.

Written by Max Miller, "Speak to the Earth," was first introduced in June, 1955.

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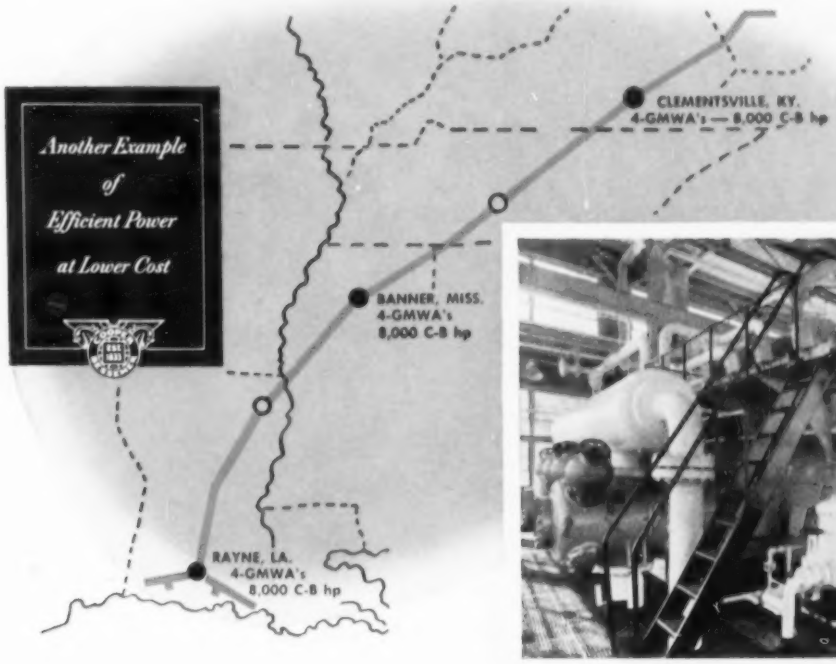
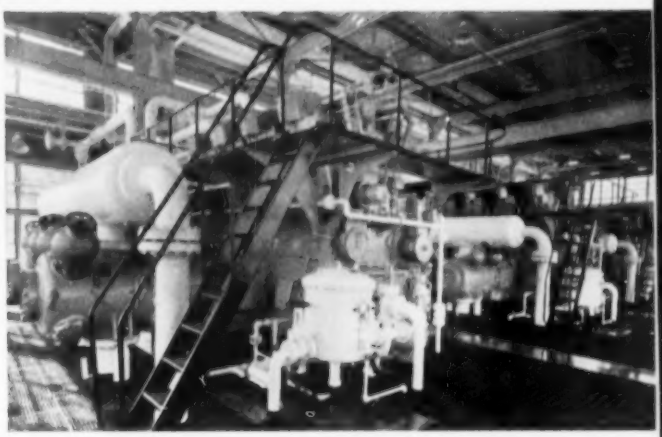
A-751

Printed in U. S. A.

PUSH-BUTTON OPERATION

on Gulf Interstate's Mainline . . . with Cooper-Bessemer GMWA's at 3 Key Stations





Shown here from the compressor cylinder side are four of the GMWA compressors used in Gulf Interstate's transmission of natural gas from fields in southern Louisiana to West Virginia.

• GULF Interstate Gas Company has designed its compressor stations for one man, semi-automatic push-button operation and has installed 2,000 hp Cooper-Bessemer GMWA compressors at three stations on their new 1,150-mile gas transmission system.

Shown here is the compact compressor arrangement in one of these plants . . . Rayne, La. This important station, at the junction of the two gathering laterals and mainline starting point, is equipped with four 8-cylinder GMWA units, identical to those in the Banner and Clementsville stations. Each of these Cooper-Bessemer installations offers top automatic operating efficiency without sacrificing flexibility.

Helping push natural gas to the northeast, these dependable Cooper-Bessemer units can be relied upon to deliver continuous top availability, low operating expense, unmatched compressor flexibility and minimum maintenance demands.

All the latest Cooper-Bessemer V-angles . . . GMXA's, GMVA's, GMWA's . . . are ready to help *you* cut costs on heavy-duty compressor requirements from 200 to 3000 hp. For further information, contact the Cooper-Bessemer office nearest you.

Main compressor building of the 8,000 hp Cooper-Bessemer powered Rayne station.

MOUNT VERNON, OHIO

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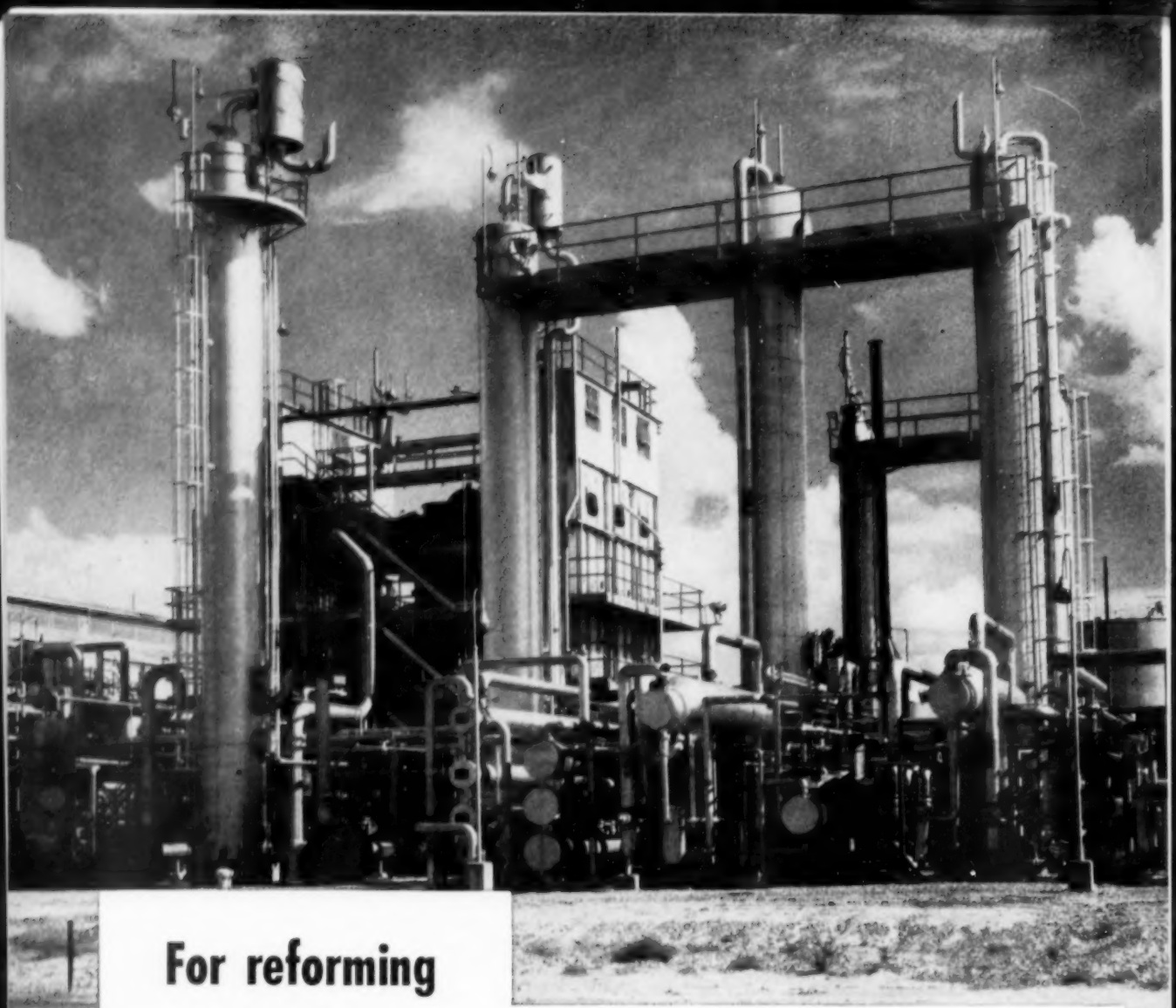
New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS



For reforming natural gas **Stainless Steel**

If you could peek inside equipment used for production of synthetic gas and hydrogen, you would see a veritable showplace for Stainless Steel.

Without Stainless Steel tubing and devices, maintenance costs would go through the roof. With Stainless Steel, the greatest freedom from severe petrochemical service is the usual result.

Of course, there is the job of selecting just the right Stainless Steel composition . . . the composition with the best performance cost ratio. This problem is discussed in our booklet, "Performance of Stainless Steel in Petroleum Refinery Service."

Your copy is waiting. Just write to United States Steel, Room 5191, 525 William Penn Place, Pittsburgh 30, Pa., and we shall be glad to send you a copy.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
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UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

See "THE UNITED STATES STEEL HOUR"—Televised alternate weeks—Consult your newspaper for time and station.

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

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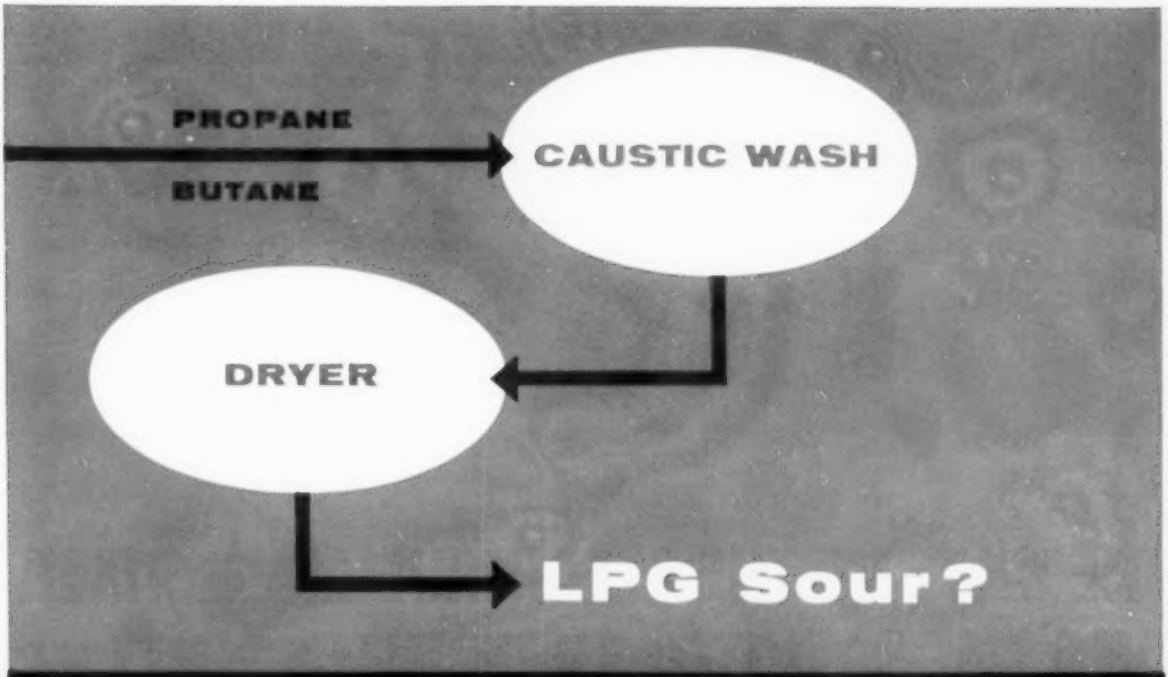


Dry it sweet every time with DRIOCEL S®

DRIOCEL S IS NEW. It is a low-cost, activated bauxite desiccant specifically developed to overcome souring of LPG products during the final drying step.

DRIOCEL S PERFORMS A THREE-WAY TASK.

1. It *does* a thorough job of drying the liquefied products.
2. It *does not* exhibit a souring reaction with sulfur compounds which originate in sour gases and crudes —escape the caustic wash—are entrained in the pre-dryer stream (which may deceptively test "sweet")—and then are decomposed in the dryer by ordinary desiccants to yield sour products.
3. Driocel S *does not* act as an acid polymerization catalyst toward heavy ends of the liquefied gases.

LONG SERVICE LIFE—Initial installations put on stream over two years ago are still operating.

THE SPECIFIC PROPERTIES of this new drying agent also suggest its use in the drying of chlorinated and fluorinated hydrocarbons.

Under the well-known brand name of Driocel, M & C offers a *complete* line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases—further proof of our ability to solve many a tough processing problem with versatile sorptive minerals. The coupon will put us to work for you.

ATTAPULGUS **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 Essex Turnpike, Menlo Park, N. J.

Please send me without obligation:

- ☐ Bulletin: "Bauxite As A Drying Agent"
- ☐ Generous sample of Driocel S

name _____ title _____

company _____

address _____

city _____ zone _____ state _____

 (To obtain more data on advertised products see page 122)

S/K apades in industry

"I'm Fed Up!" screamed Simpkins, the Superintendent. "I've had it, and I'm fed up. That mixer has Got To Go!"

"But boss," soothed Barney, the Bird Dog Assistant, "that mixer can't be shut down. The Front Office has already told us . . ."

"Out!" interrupted the seething Super.

". . . that if we can't spark up production, changes are gonna be made," finished Barney.

"You're Right," said Simpkins coldly. "You're *so* absolutely, *definitely* right. Changes *are* gonna be made—Now!"

"Can't we talk this over, man-to-man?" mumbled Barney. "Seems to me . . ."

"Sure we can talk it over," said the Super, "*sure* we can. C'mere m'boy. I'll talk, and you listen.

"You've got two weeks. Two weeks to Get That Mixer Out and something an awful lot better in. That's your mission, boy, an out and out case. The mixer or you. Think it over," said the Super, with a man-to-man pat on the back.

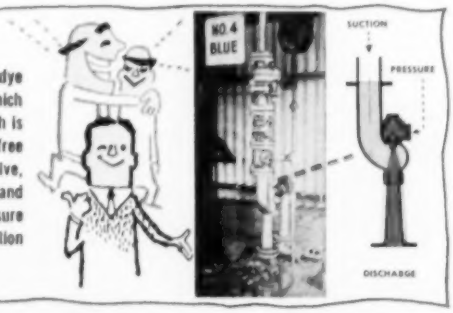
THE CASE OF THE MACHIAVELLIAN MIXER AND THE SATIATED SUPERINTENDENT

". . . need your help," phoned Barney to his nearest SK Sales Engineer. "I've thought over this problem I've told you about, read SK's Bulletin J-1, and I think a jet of some kind is right for the job."

"YOU'RE RIGHT," replied SK's nearest Sales Engineer. "You're so absolutely, definitely right. An SK Water Jet Eductor will do the job, and I'll be right over to tell you how."

NO BIRD DOG NOW

Now, gasoline dyes are mixed this way. A container of gasoline dye is weighed on a scale and the operator notes the reading at which he should stop addition of dye. He takes a flexible hose, which is connected to the suction connector of the eductor, inserts the free end of the hose into the powdered dye, opens the eductor valve, and draws the proper amount into the eductor where it mixes and blends with the gasoline which is used as the eductor pressure fluid. No bird dog now, Barney is consulted on every production problem—bowls with Simpkins every Thursday night.

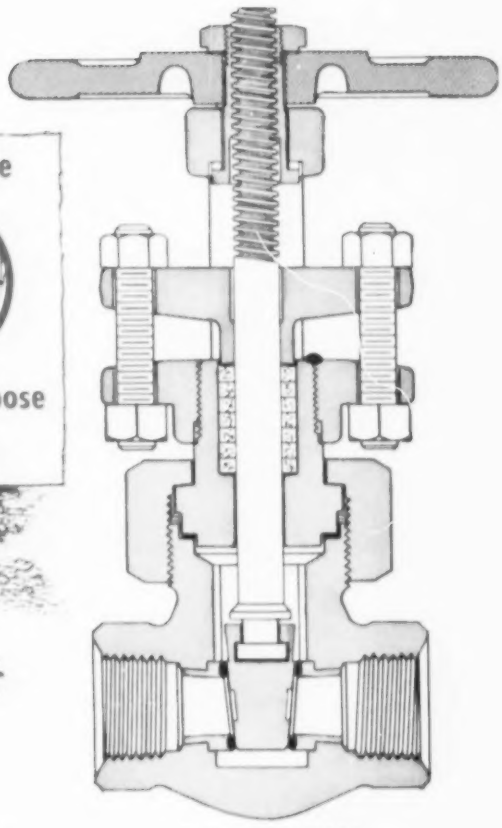


MORAL:

Get acquainted with all types of SK Jet Apparatus. Send for a copy of Condensed Bulletin J-1. Make use of a qualified specialist, your nearest SK Sales Engineer.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2247 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 10-RA.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.



G-P series 5-9530

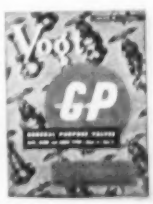
Hard faced* Seating

. . . at no extra cost!

STELLITE *faced seating surfaces* are among the many plus advantages offered by Vogt General Purpose Valves. Fusion welded to the removable stainless steel seat rings of gate valves and to the integral seat of globe and angle valve bodies, tough, long-wearing STELLITE affords amazing resistance to erosion, corrosion and galling.

The new line of Vogt drop forged steel GP's completely fills the demands of industry for a line of compact, lighter weight, shorter face-to-face valves. They assure operation economies and longer life and are available in a complete range of sizes and types from ¼" to 2". They are rated 800 pounds at 850° F. and 2,000 pounds at 100° F. Send today for free catalog.

Adv. No. 2 in a series describing the features of Vogt G-P Valves.



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Vogt

GENERAL PURPOSE GP Vogt FOR BETTER VALVES

DROP FORGED STEEL

VALVES

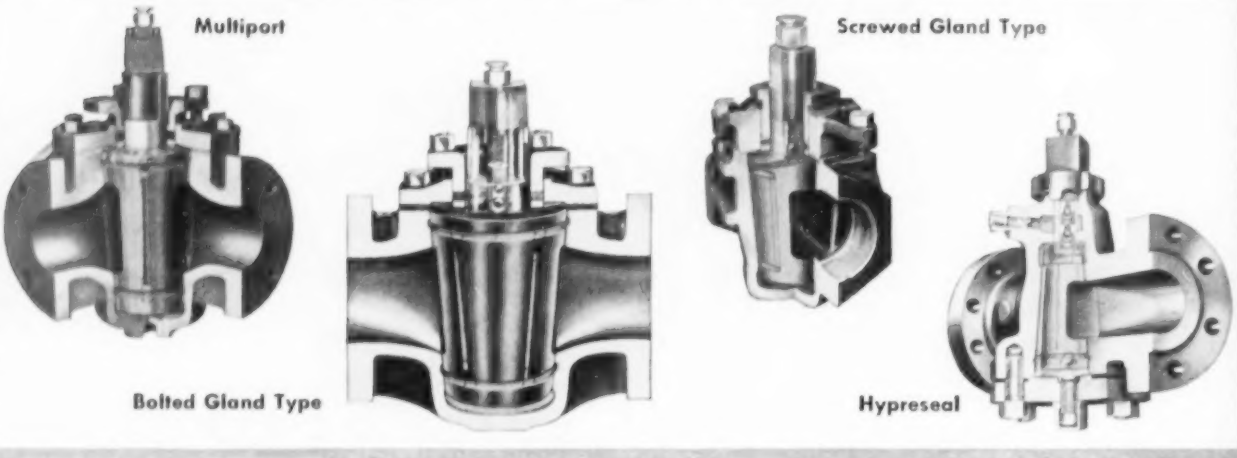
(To obtain more data on advertised products see page 122)

12 Reasons why you can't

ROCKWELL-

The Rockwell-Nordstrom valve—the *original* lubricated plug valve—has been copied often . . . but never equaled. Its leadership has been proven through 40 years of outstanding service in the petroleum, gas, chemical and process industries.

Look at the twelve Rockwell-Nordstrom valve features shown on these pages. They are the reasons why you can't buy a better valve than Rockwell-Nordstrom. Yet you pay no more (often less) than the price of ordinary valves—and you get longer service life and lower end cost than you ever thought possible. Available in a complete range of sizes and pressure ratings in semi-steel, stainless and corrosion resisting metals. Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee: Peacock Brothers Ltd.*



1.

"Sealdport" Surrounds Ports with Lubricant Pressure.* **"*Sealdport*"** grooves at both sides of the plug give complete shut-off in either direction. In the closed position, the ports are completely surrounded by a sealing lubricant film. When turning the plug, grooves exposed to the line fluid ports are automatically disconnected.

*Registered Trademark, Rockwell Mfg., Co.

2.

Positive, Quarter-Turn, Rotary Action. The tapered rotary principle is the simplest, most positive valve action known. The taper of the plug and seat maintains an intimate working contact between the two parts at all times. Quarter-turn operation is from two to five times faster than ordinary valves.

3.

Unexposed Seats Eliminate Corrosion and Erosion. Corrosive and erosive elements can wreak havoc on exposed valve seats. But in a Rockwell-Nordstrom valve the seat is *never* exposed. Material touching the plug in the closed position is scraped off when the plug turns back to open position. Critical seat areas are completely sealed by pressurized lubricant.

4.

Simplest of All Valve Designs. There are only three basic parts comprising the standard Rockwell-Nordstrom valve—(1) body, (2) cover, (3) plug . . . the only movable member. It is a mechanical axiom that "the fewer the parts, the fewer the repairs."

buy a better valve than

Nordstrom

5.

Full Floating Hypreseal Plug. The Hypreseal stem is entirely independent of the tapered valve plug except by a floating equalizer ring. The stem has a long threaded engagement in the neck of the valve body to carry the outward line pressure thrust and seals against leakage without excessive friction of deep stuffing boxes. The stem thread is lubricated and sealed by lubricant from the chamber surrounding the equalizer. Injection type packing prevents escape of lubricant around the stem.

6.

Resilient Plug Seating. In Rockwell-Nordstrom valves the plug has a small, but highly important, degree of resiliency. This prevents binding, allows the lubricant "jacking" action to function properly, and avoids unseating which would result in loss of lubricant, seat exposure or damage.

7.

Shoulder Seal. The shoulder type of stem seal is used in preference to conventional stuffing boxes. It is compact, produces a minimum of friction, and combines the functions of stem seal and thrust bearing.

8.

Smoothly Contoured Passages. The interior of Rockwell-Nordstrom valves presents an unbroken line devoid of crevices for any lodgment of line contents. Flow characteristics are designed for minimum pressure drop.

9.

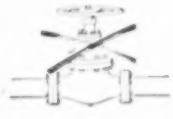
Repackable under Pressure. The Rockwell-Nordstrom Hypreseal is the only valve that can be repacked under any line pressure and in any position. This eliminates shutdown of the line. No packing gland or stuffing box is used.

10.

Adjust or Lubricate under Pressure. Rockwell-Nordstrom valves are the only type of valve that can be fully adjusted and lubricated in service. In any operating position the plug can be jacked from its seat by a few turns of the lube screw or by injections with a lubricant gun.

11.

Flow Either Way at Any Differential. Rockwell-Nordstrom valves are not restricted to one-way flow. There is no single "pressure side" requiring a specified end to go on the upstream side. Since the Rockwell-Nordstrom non-wedge action and transfer of plug pressure to the lubricated seat allows *operation at any pressure differential* within its range, galled or frozen valves and by-passes are eliminated.

12. 

No Bonnet Cavity—Saves Weight and Space. Compare the overall dimensions of Rockwell-Nordstrom valves with any other type of valve and note the saving in space. For most Rockwell-Nordstrom valves the space occupied is little more than the diameter of the line pipe flanges.

ROCKWELL-Nordstrom VALVES

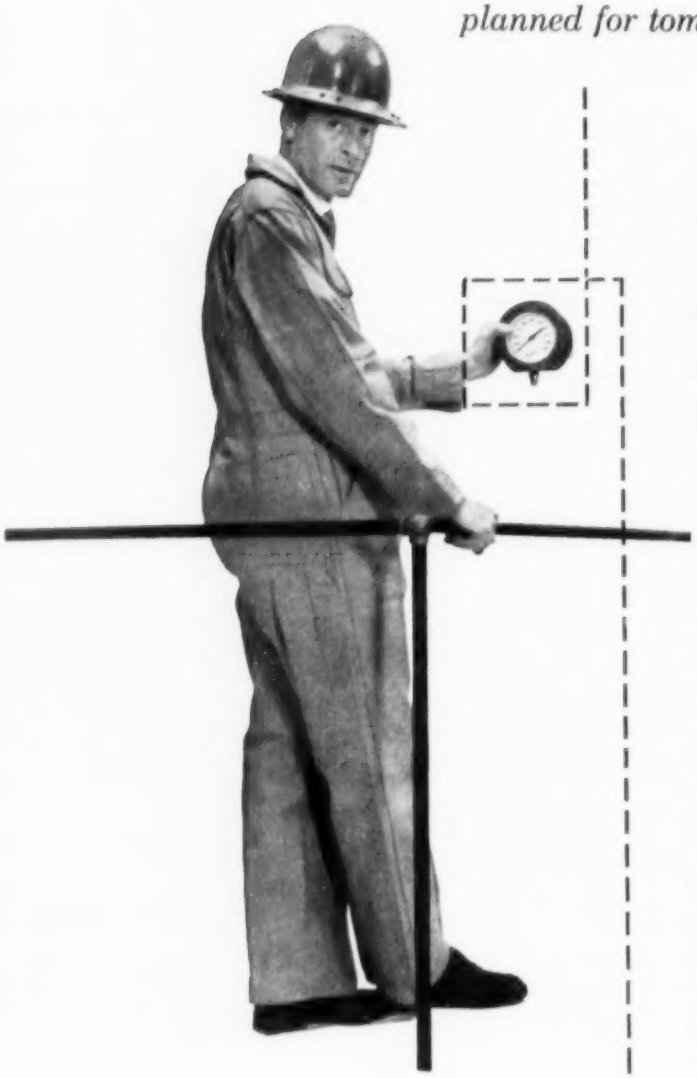
Lubricant Sealed for Positive Shut-Off

40th YEAR *of lubricated plug valve leadership*

Because

Norden-Ketay

planned for tomorrow...



ACRAGAGE®
SOLID FRONT
PRESSURE GAGES
ARE AVAILABLE TODAY
AT NO EXTRA COST!

The first to apply the advantages of solid front case design to pressure gages as a standard feature... Norden-Ketay remains the *only* manufacturer offering you this big plus at no extra cost.

SOLID FRONT CASES—full rear-area blow-out disc provides complete safety in every pressure range; permits quick, easy adjustment and calibration.

CAPILLARY BLEEDER—permits complete filling bourdon tube assembly without necessity of cumbersome equipment for evacuation; provides for purging of bourdon tube assembly.

EXCLUSIVE SHOCKSTOP FEATURE—integrally mounted pulsation dampener is NOT dependent upon restrictive orifices which tend to clog.

PNEUMATIC TRANSMISSION SYSTEMS—pressure indication at the process and in the control area thru transmission of a simple, safe air signal.

For the name of nearest distributor and full details, write for file #20B.

NORDEN-KETAY CORPORATION
INSTRUMENT AND SYSTEMS DIVISION
Wiley Street, Milford, Connecticut

INDICATING PRECISION PRESSURE GAGES. REMOTE INDICATING DEVICES. ANALOG DIGITAL CONVERTERS. FORCE BALANCE PRESSURE TRANSDUCERS. ELECTROMECHANICAL CONTROL SYSTEMS. AIRBORNE RADAR. SHIPBOARD LINE CONTROL EQUIPMENT. AIRCRAFT FUEL FLOW INSTRUMENTATION. ACCELEROMETERS.

These are our contributions to tomorrow's better oil additives

The day is not far off when *Very Heavy Duty* lube oils will be needed to provide optimum efficiency in engine oiling systems. Better barium compounds will provide their extra measures of protection to detergent additives.

To be prepared for this day, we have . . .

1. Substantially increased our reserves of barytes.
2. Doubled our electric-furnace capacity.
3. Developed flake Barium Octahydrate and Barium Pentahydrate . . . advanced forms of soluble barium values.
4. Initiated bulk shipment of barium alkalis in covered hopper cars to serve large additive users.
5. Pioneered production of dense, crystalline electric-furnace barium oxide.
6. Piloted an advanced barium-oxide process developed by Westvaco engineers.

When better barium-based additives are needed, still better barium compounds will be available from Westvaco.

If you are working with lube oil additives, we would like to send you a copy of the new 24-page booklet giving complete information on WESTVACO® Barium Chemicals.

AMERICA'S OLDEST AND LARGEST PRODUCER OF

BARIUM

ALKALIS

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco CHEMICALS

Westvaco Mineral Products Division

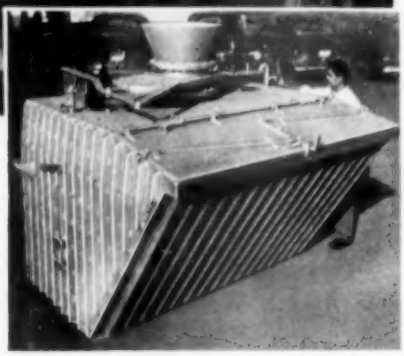
FOOD MACHINERY AND CHEMICAL CORPORATION

General Offices • 161 East 42nd Street, New York 17

CHICAGO, ILLINOIS • CINCINNATI, OHIO • HOUSTON, TEXAS • NEWARK, CALIFORNIA

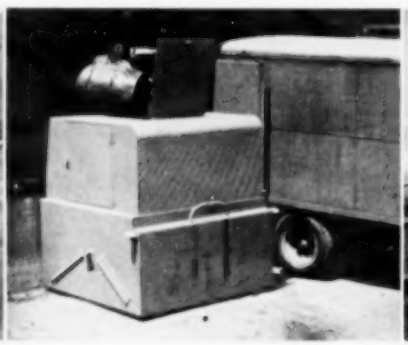
These save

Dempster-Dumpster serving a 6 cu. yd. container with cooling fins for handling a high temperature product.

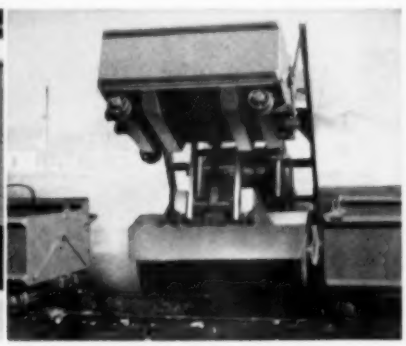


Here are a few of the hundreds of Detachable Containers we have built to solve handling problems of every description. A few others not shown include those with compartments . . . with insert containers . . . fully-insulated . . . lined with lead . . . lined with fire brick . . . with windows and doors . . . with casters . . . flat bottoms and open at one end . . . with teeth . . . with shelves for tools and supplies—and we could describe hundreds more, all served by one Dempster-Dumpster and only one man, the driver.

This 3 cu. yd. Container has skids for fork lift truck transfer.



10 cu. yd. Container widely used for refuse and combustible wastes.



Flanged wheel equipped containers for remote loading.

5176

DEMPSTER

4 manufacturers to $82,000.00 annually handling waste materials!

These four industrial plants expect to save, in labor costs alone, during the first five years service of the Dempster-Dumpster System—

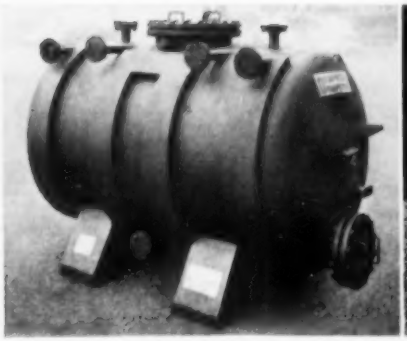
A PLASTICS PLANT: $26,958.00 savings on an investment of $9,523.50 in Dempster-Dumpster equipment. Savings alone pay for equipment in two years.

A CHEMICAL PLANT: $204,076.75 savings on an investment of $40,968.00 in this equipment . . . savings pay for equipment in one year.

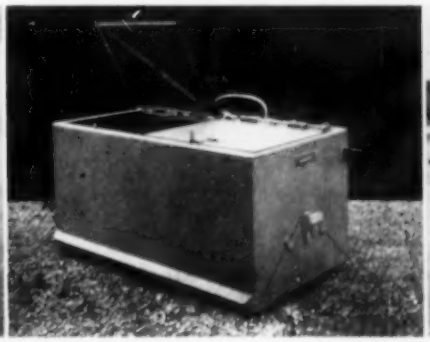
AN AUTOMOTIVE PLANT: $135,000.00 savings on an investment of $19,272.00 . . . savings pay for equipment in 9 months.

A PAPER AND PULP MILL: $43,104.00 savings on an investment of $10,750.00 . . . savings pay for equipment in 1¼ years.

Those are typical examples. Visualize a Dempster-Dumpster, operated by only one man, the driver, serving scores of big steel containers, one after another, in your plant. Containers of many designs and types, handling waste or salvable materials, raw or finished products, fluids including acids, combustibles, dusty materials—anything that can be handled in up to 21 cu. yd. detachable Dempster-Dumpster Containers . . . payloads up to 19 tons. Savings are tremendous! Take advantage of our free engineering service, which determines by fact-finding survey the cost cutting possibilities of this system in your plant. Dempster Brothers, Inc.



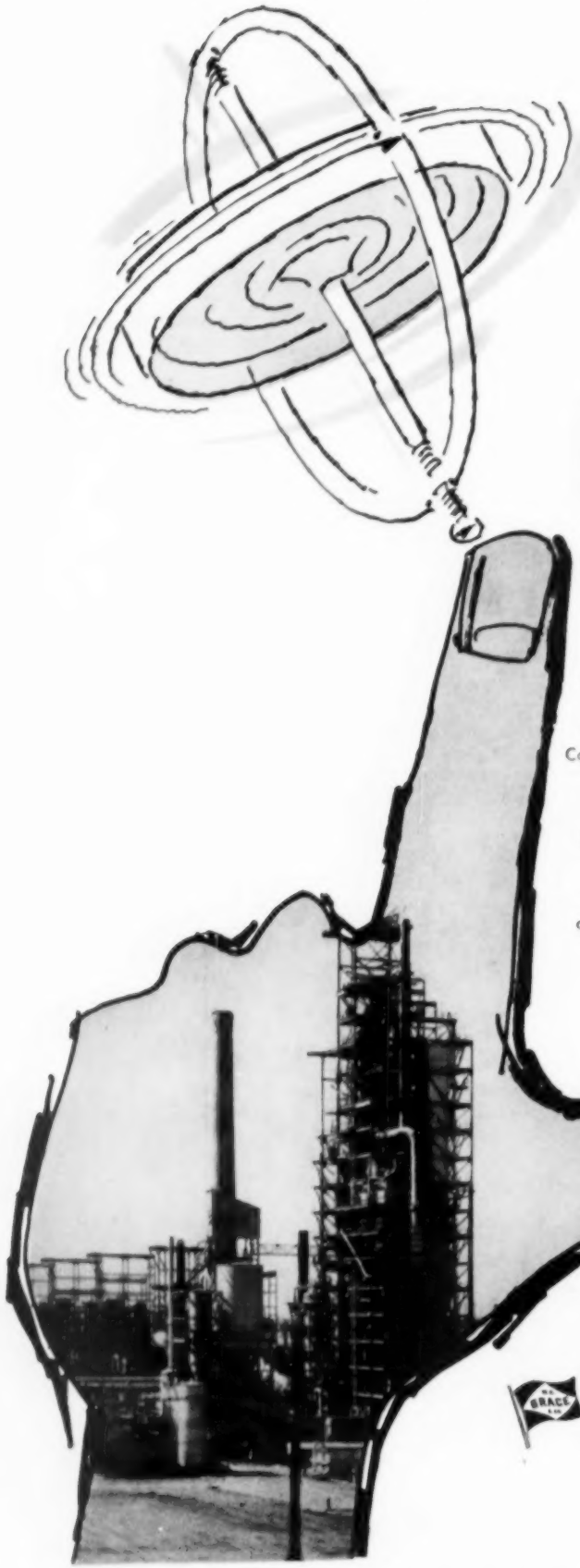
600 Gal. stainclad tank with brine cooling channels.



A Container available up to 10 cu. yds. with or without lids for many uses.

A 9 cu. yd. container for handling packaged products.

BROTHERS 526 Dempster Building, Knoxville 17, Tenn.



Catalysts

Require stability, too . . .

and with Davison's *LOW DENSITY* catalyst you get commercially proven higher stability. You get a higher degree of thermal stability without affecting the resistance to attrition or other proven qualities of Davison catalysts. Commercial fluid cracking units, operating for over one year, demonstrate that this stability leads to:

Higher surface area—Higher pore volume—Higher pore diameter—Higher catalytic activity—Improved regeneration

This new *LOW DENSITY* catalyst is yet another Davison catalyst manufactured with controlled catalyst characteristics. At Davison you can get the catalyst best suited for your unit. For information on Davison's new *LOW DENSITY* catalyst, as well as other Davison catalysts, see your Davison representative or write.

Progress Through Chemistry

DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

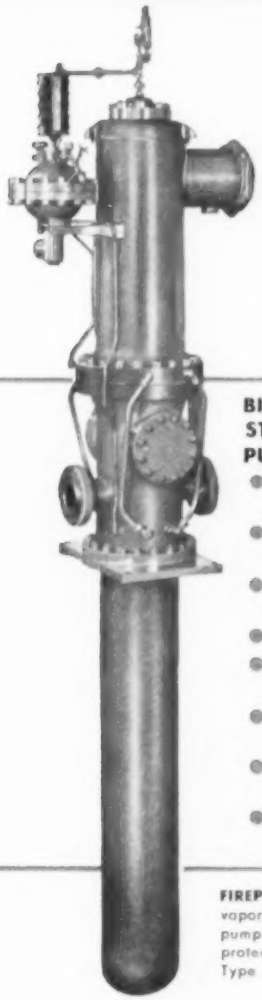
Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.
In Canada: Davison Chemical Company Ltd., Toronto

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, TRIPLE SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS AND SILICOFLUORIDES. SOLE PRODUCERS OF DAVCO® GRANULATED FERTILIZERS.

Bingham

STUFFINGBOXLESS PUMPS

HANDLE LIGHT HYDROCARBONS* AT HIGH SUCTION PRESSURES



NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300°).

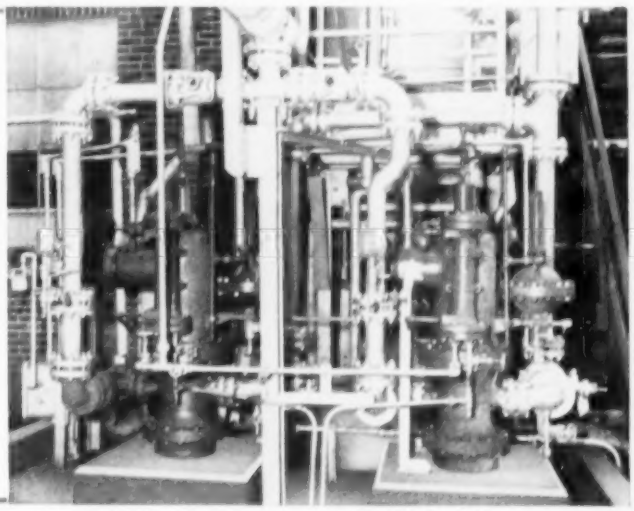
Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F. and higher also can be handled.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

*And other volatile liquids.

BINGHAM STUFFINGBOXLESS PUMPS OFFER:

- Lower overall installed cost
- Less operating attendance
- No misalignment of moving parts
- Smooth operation
- No auxiliary lubricating system
- No exposed moving parts
- Positive motor cooling
- All parts are accessible



FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor to atmosphere or leakage from outside into pump is impossible. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KT Multi-Stage Stuffingboxless Pump illustrated.

Bingham Type KT Stuffingboxless Pumps handling liquid propane under high suction pressure at Esso Standard Oil Company refinery, Bayway, New Jersey.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

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New BETTER way to insulate plant piping

gb SNAP*ON

Less than two years ago it was a time-consuming and expensive job to insulate plant piping. Not so today, thanks to a new concept in pipe insulation — G-B Snap*On, the new one-piece molded pipe insulation of fine glass fibers.

Snap*On goes on piping far quicker and easier than any other pipe covering, with less down-time or interruption of plant processes. It comes in 6' sections that can be snapped over piping in a matter of seconds. It's exceptionally light in weight, easy to apply even in tight spots. No time is wasted in clean-up, since Snap*On is clean and dustfree, won't crumble when dry or get muddy when wet.

All this adds up to quicker, easier application than you've ever experienced. So don't fail to try Snap*On the very next time you need insulation from chilled or heated piping where temperatures do not exceed 350°. You'll find there's absolutely *nothing like it for economical application, thermal efficiency and permanence.*

FOR SAMPLE AND NEW BROCHURE,

write today or call the G-B Distributor in any of 57 cities. You'll find him listed in the Yellow Pages under "Gustin-Bacon Insulations."

GUSTIN-BACON *Manufacturing Company*

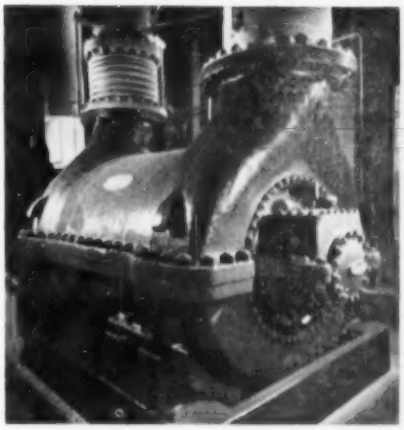
GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe Couplings and fittings • Railroad gaskets and supplies

266 W. 10th St., Kansas City, Mo.

(To obtain more data on advertised products see page 122)

Carrier Centrifugal Compressor



on the job at

The Pure Oil Company

This Carrier Centrifugal Compressor plays an essential role in the manufacture of high-test motor fuels from heavy oils at the Lemont, Illinois, refinery of The Pure Oil Company. It supplies compressed air to a fluid catalytic cracker to convey and regenerate the chemical catalyst.

Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration—up to 10,000 hp in a single unit. Hundreds of these dependable, efficient Carrier machines are on the job at dozens of refineries across the country—The Atlantic Refining Company, Cities Service Oil Company, Sinclair Oil Corporation, The Texas Company. May we assist *you?*

If you'd like a copy of our booklet

"Centrifugal Compressors for Industry"

please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

Carrier

centrifugal compressors

refrigerating equipment

BETZ • *A Great Name In Water Conditioning*

Welcome visitor...

The Betz District Engineer is a welcome visitor wherever he goes. As our personal representative to industrial plants, petroleum installations, institutions . . . plants like yours, he plays an all-important role in our continuing efforts to engineer *controlled* water conditioning.

His job carries many responsibilities. For example, he

. . . instructs your plant operators in Betz-engineered water conditioning control techniques (chemical feed, water testing, chemical adjustment, blowdown control, etc.).

. . . makes regularly scheduled visits to your plant to review operating conditions.

. . . reviews plant control and offers "on-the-spot" constructive criticism and advice.

. . . checks testing procedures, test solutions and chemical feed equipment.

. . . inspects plant equipment and visually observes the results obtained.

. . . discusses any and all water problems with you and your operating personnel.

. . . prepares and submits a complete written report before leaving your plant.

And equally important, he works closely with the Betz headquarters engineering staff to assure the individual attention required for sound, economical water conditioning.

Next time a Betz District Engineer calls, ask him to explain how Betz *completely-integrated* water conditioning service can obtain results in *your* plant. He'll be happy to give you the details.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

THE SURFACE IS IMPORTANT!

In heat exchange applications, the condenser tube surface is vitally important. By increasing the surface area, heat duty is increased, costs reduced and on-stream time greatly lengthened.

Wolverine Trufin* Type S/T will produce this end result! Type S/T obtains its increased surface area from its fins which are squeezed directly from the tube wall. Because of its extruded fins, Trufin packs more heat transfer surface into every foot of tube—steps up capacity by as much as 2½ times over prime surface tube. Trufin makes it possible to design smaller, more effective heat exchangers and condensers. When retubing with Trufin Type S/T you obtain a much greater heat transfer surface area and thus can increase the capacity of your unit.

Since its fins are actually a part of the tube wall, they cannot shake loose because of vibration, thermal shock or varying pressures. Under the most severe operating tests, Trufin has proved conclusively that it withstands fouling for longer periods than does prime surface tube. Trufin-tubed units go on-stream and stay on-stream. Efficiency is constant, costly maintenance time reduced.

Trufin Type S/T can be directly substituted for plain tube with conventional tools and methods. The ends of the tube are left without fins and the tube is designed with the outside diameter of the plain end slightly larger than the O.D. of the finned end. This allows the tube to be inserted into a bundle and rolled into the tube sheet by regular methods.

Yes, surface is important and Trufin has the surface you need. Next time you order condenser tube specify Trufin Type S/T. It is available in a wide range of sizes and alloys of copper and aluminum. Write, too, for your copy of the Wolverine Trufin Opportunity Book. It's packed with valuable information.

WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

REG. U.S. PAT. OFF.

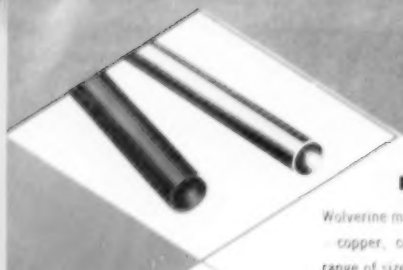
This is Wolverine Trufin* Type S/T—the integral finned condenser tube with the extended surface that means increased performance and economy.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK



PRIME SURFACE TUBE

Wolverine manufactures prime surface tubing in two metals — copper, copper base alloys and aluminum in a wide range of sizes.

DUPLEX PRIME SURFACE TUBE

Here's a tube designed to handle two types of corrosive attack simultaneously. It is composed of a tube of one metal and a liner of another. The combination can be any alloy you need to meet special conditions.

DUPLEX TYPE S/T

This tube also is designed for specific corrosive conditions. But, like Trufin, it has integral fins — will boost heat transfer efficiency. It can be used instead of prime surface tube.

TRUFIN TYPE L/C

A high finned, lightweight aluminum tube is mechanically bonded to an interior liner of the alloy which best beats your corrosion hazard. It provides maximum heat transfer and trouble-free performance at low cost.

U-BEND PALLETS

This new Wolverine idea cuts time, reduces storage problems, and saves money. U-bend condenser tubes — either finned or prime surface — are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

FIELD ENGINEERING SERVICE

This is a Wolverine "extra" — a staff of highly skilled tubing technicians. You can get experienced help in solving problems dealing with alloys, corrosion, design or fabrication.

*REGISTERED U.S. PATENT OFFICE

BACKED BY EXPERIENCE

In addition to Trufin* Type S/T, Wolverine has also pioneered in the development of a complete line of condenser tubes for the processing industry. Such a line-up could only come from years of experience—the kind of experience that studies an industry's needs and then develops products to meet those needs.

Illustrated are condenser tubes designed to bring new efficiency to every type of operating condition. Each is the product of Tubemanship—Wolverine's way of combining experience, research, rigid quality control and sound engineering into every foot of every tube.

Look these products over—study them in relation to your own operating needs—and then specify the one that will do the job. Wolverine's Condenser Tube Catalog contains complete size and alloy information. Write for your copy today!

WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE
Division of Calumet & Hecla, Inc.

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

Even without this famous guarantee

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free.
COPR. 1937 THE RIDGE TOOL CO. ELYRIA, O.

Genuine
RIDGID
would still be the World's Most Popular Pipe Wrench

. . . and no wonder— millions of users know it out-performs, out-lasts all others!

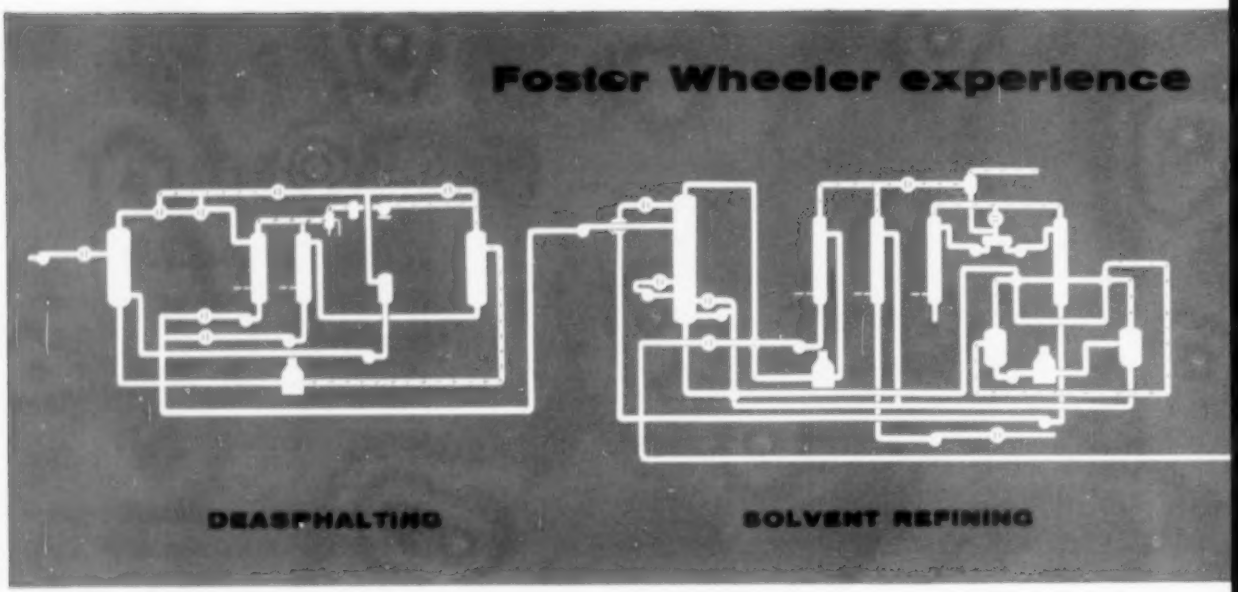
It's the "RIDGID" name that guarantees you everything you want in a pipe wrench—instant bite on the pipe, instant let-go—it can't lock, assured by patented hookjaw suspension . . . handy pipe scale, easy-spin adjusting nut, comfort-grip I-beam handle . . . and every one factory-tested before shipment! Always most for your money. . . your Supply House has them!

You get more quality and more-for-your-money in all RIDGID Pipe Tools.

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio, U.S.A.

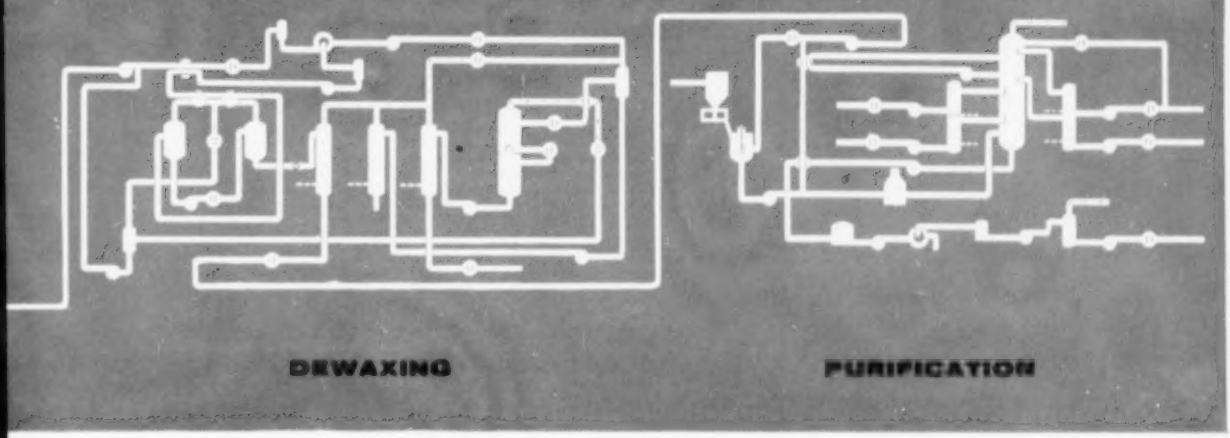
lube



Complete lube oil plant, designed and constructed by Foster Wheeler at England's largest refinery. Process units, in sequence from right to left, are as follows: propane deasphalting, phenol extraction, propane dewaxing and clay contact-vacuum rerun. Foster Wheeler is now building complete lube plants in the United States and Iraq.

oils

points the way to lower-cost production



NEW ADVANCES in refining processes and equipment have resulted in substantial increases in the overall efficiency of lubricating oil production—contributing to higher sustained output of high quality oils at lower unit production cost.

In the construction of new lube oil plants or modernization of existing facilities, Foster Wheeler's long experience in this specialized field is your best assurance of complete satisfaction, from initial planning to final installation and on-stream service. Foster Wheeler process design engineers offer more than 20 years of continuous and cumulative experience in lube oil manufacture. Their intimate knowledge of all phases of design, engineering and construction—plus their close relationship with all licensor companies—can save time, effort and expense in any expansion or modernization program. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

INTALOX

The Unique

SADDLE PACKING

for

GREATER TOWER EFFICIENCY
LOWER COST

Unretouched View of an Irrigated Tower Section Photographed through a Glass Tower.

The surface area of the packing in a column that is in contact with both liquid and gas is the only surface area that counts. Packings that "nest" or "pattern pack" have a low ratio of effective area to actual area. Pressure drops rise, flooding limits lower.

Examine the photograph above. There is no blocking of surface area there. The unique design of Intalox makes certain that no two pieces of Intalox can nest or cover each other to such an extent that any significant portion of the packing surface is rendered ineffective.

This greater randomness in a packed bed means better packing performance — greater tower efficiency at lower cost.

WRITE FOR THIS NEW 16-PAGE BOOKLET ON INTALOX SADDLE PACKING

This new booklet (Bulletin S-29) gives detailed comparative data on the relative efficiencies of various packings — shows how Intalox Saddles can help you reduce tower heights, lower gas pumping costs, or obtain greater capacity from your present tower. Free on request. Write

THE U.S. STONEWARE CO.
Akron, Ohio

U. S. STONEWARE

Akron 9, Ohio

358D-1

TYPICAL DATA ON INTALOX® SADDLE PACKING

Nominal Size, Inch	Approximate Number per Cu. Ft.	Approximate Weight per Cu. Ft., Lb.	Approximate Surface Area Sq. Ft./Cu. Ft.	Percent Free Gas Space	Equivalent Spherical Diameter Dp, Inch
¼	117500	45	300	75	0.20
½	20700	41	190	78	0.32
¾	6500	40	102	77	0.48
1	2385	38	78	77.5	0.68
1½	709	35	59.5	81	0.96
2	265	38	36	79	1.38

®Trade name, The U. S. Stoneware Co.

 (To obtain more data on advertised products see page 122)

Solo-aire units condense and cool three streams from a refinery process unit

SERVICE NUMBER ONE

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	47° API
Inlet Temperature	340° F
Outlet Temperature	140° F
Heat Removed	19,500,000 BTU/hr.

SERVICE NUMBER TWO

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	31° API
Inlet Temperature	463° F
Outlet Temperature	135° F
Heat Removed	34,100,000 BTU/hr.

SERVICE NUMBER THREE

Hydrocarbon liquid cooler.

Gravity	43° API
Inlet Temperature	430° F
Outlet Temperature	130° F
Heat Removed	10,000,000 BTU/hr.

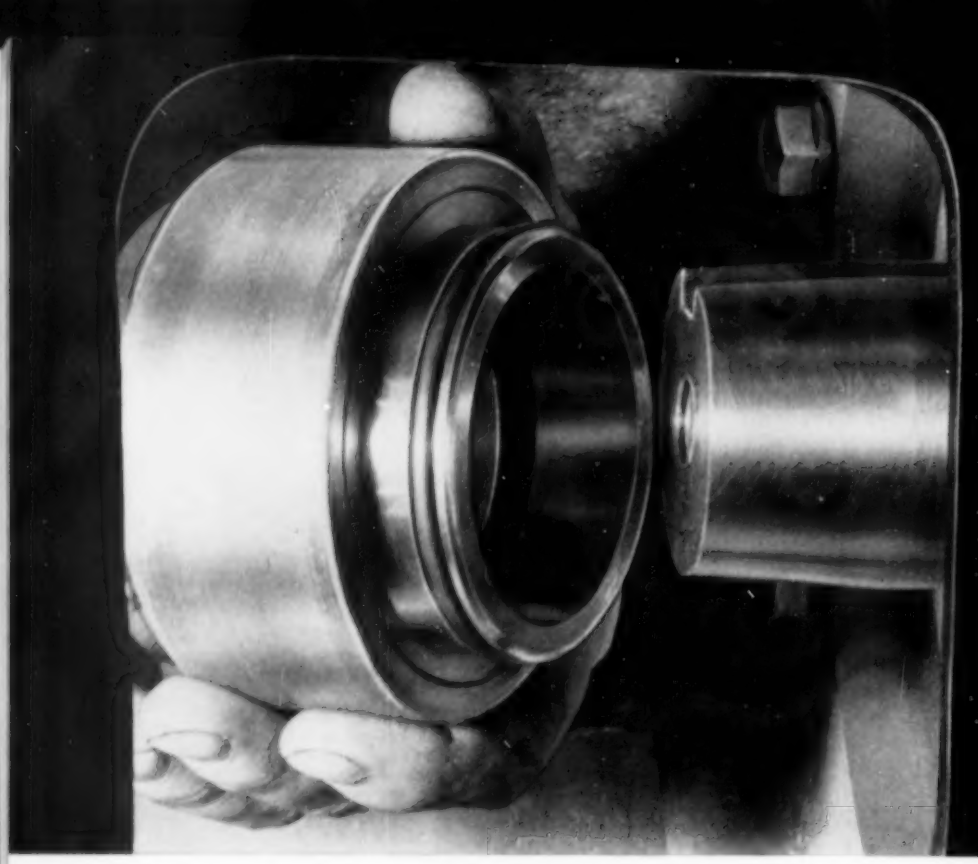
If water rather than air were used as a cooling medium for these services, about 4500 gallons per minute would have been required.

These Hudson Solo-aires are operating with complete satisfaction in one of the world's major oil refineries. They were designed and built to rigid specifications for oil refinery service including API-ASME Code for pressure parts, explosion proof motor drives, and corrosion resistant structural steel parts, and were specially designed to fit into a congested area.

In addition to Solo-aires Hudson manufactures the COMBIN-AIRE unit, which uses a combination of air and water for cooling, and also cooling towers for conventional cooling of water.

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS



CARTRIDGE SEAL slides off mixer shaft, which uncouples to permit removal. New cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

Cut mixer maintenance 60%

with this cartridge-type *rotary seal*

Stops leakage! Runs years without adjusting! Slides off for fast, easy replacement!

If you're mixing or blending in big tanks, here's the newest way to slash mechanical mixer upkeep as much as 60%.

For here at last is a rotary mechanical seal—optional on new LIGHTNIN Side Entering Mixers—that stops leakage around the tank, ends stuffing-box repacking and adjusting for good.

And for the first time ever on big-tank mixers, you can replace this seal in a jiffy if you ever have to! No need to dismantle or remove the mixer from the tank. No need to drain the tank. No special skill required!

Even under a full head of liquid in the tank, the seal-change job is so simple it takes only minutes. The mixer shaft retracts to seal the tank, then uncouples. The seal cartridge slides off in one piece. A new cartridge slides on; the mixer shaft automatically realigns itself when recoupled—and you're back in operation.

The LIGHTNIN seal cartridge is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.

Already, many oil companies are using LIGHTNIN Seals—and saving many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today—he's listed in your copy of Refinery Catalog. Or get the facts by mail: send the coupon for 8-page, fully illustrated bulletin.

Lightnin® Mixers

MIXCO fluid mixing specialists

Left: **NO STUFFING BOX** to repack or adjust. No leakage around the tank. When correctly applied, seal runs for years without adjustment. *Right:* **REPLACEMENT** is simple, even with tank full. Mixer shutoff closes like a valve to keep liquid in the tank while seal is being changed.

☐ ***Quick!*** **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

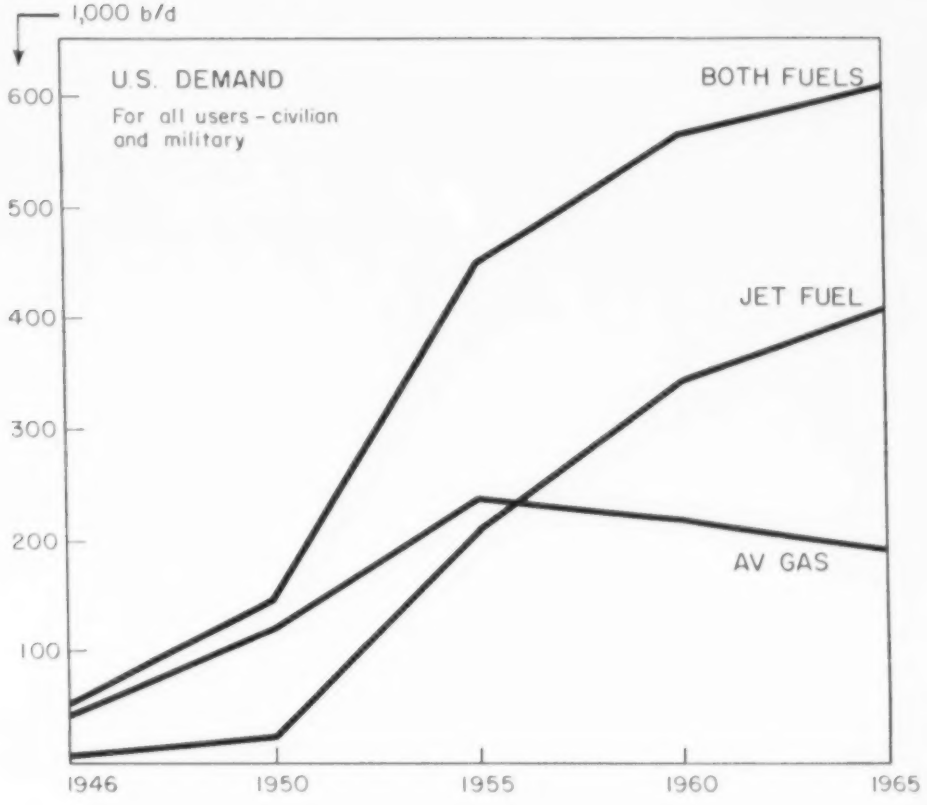
- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering propeller types: ¼ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-b Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.

Petroleum Processing
FEBRUARY 1956



When the Airlines Fly Jets . . .

What will it mean to the refiners?

By V. B. GUTHRIE, Associate Editor

WITHIN the next four years, at least one hundred seventy-four straight jet type transports will be put into service by about 15 big U. S. and foreign air lines for long distance flights both in this country and abroad.

These new sky ships will herald the advent of the jet era in civilian flying. Their direct impact on the petroleum processing industry is demonstrated in the chart above. Indirectly and in ways not yet foreseen, the entire national economy will be affected.

What is this impact? How big is it? What kinds of fuel and how much will the oil companies have to supply? The chart shows the shift anticipated in the U. S. demand for the new jet fuels and conventional aviation gasoline.

Jet fuel demand—chiefly the kerosine type materials rather than the JP-4 grade specified by the military—will shoot up rapidly as the new planes come into service. The table shows it will probably overtake demand for aviation gasoline very soon. Consequently, avgas demand in turn will soon start dropping off.

These tentative conclusions are warranted based on studies made by aircraft and engine manufacturers as to the fuels which will be used by commercial airlines in the coming jet age:

1—Residual oils, and even heavy distillate fuels, will not prove acceptable for the straight jets nor for the turbo-prop engines. The performance characteristics of these fuels and the problems associated with handling them in the frame of the aircraft, in the engine and on the ground overcome their economic advantage, at the present stage of development in this field.

Estimated U. S. Demand for Aviation Gasolines by Uses

(Bbls. Daily)

Year	Airlines	Total Civilian	Exports	Civilian Plus Exports	Military	Total
1946	18,000	25,500	5,400	30,900	11,200	42,100
1950	34,500	45,300	16,600	61,900	65,800	127,700
1955	66,000	78,000	45,000	123,000	115,000	238,000
1960	74,800	88,000	35,000	123,000	100,000	223,000
1965	72,600	89,000	30,000	119,000	80,000	199,000

Estimated U. S. Demand for Jet Fuels by Uses

(Bbls. Daily)

Year	Airlines	Total Civilian	Exports	Civilian Plus Exports	Military	Total
1946	———	500	———	500	1,000	1,500
1950	———	2,100	———	2,100	21,000	23,100
1955	1,700	12,000	1,000	13,000	200,000	213,000
1960	31,500	41,000	5,000	46,000	300,000	346,000
1965	71,200	81,000	10,000	91,000	320,000	411,000

Jet Planes on Order at end of 1955

U.S. Airlines

Company	Type of Plane	Quantity	Cost
American Air Lines	Boeing Type 707	30	$135,000,000
Braniff Airways	Boeing Type 707	5	30,000,000
Continental Air Lines	Boeing Type 707	4	21,300,000
Eastern Air Lines	Douglas DC-8	18	165,000,000
National Air Lines	Douglas DC-8	6	36,000,000
Pan American World Airways	Douglas DC-8	25	
			269,000,000
	Boeing Type 707	20	
United Air Lines	Douglas DC-8	30	175,000,000
	Sub Total	138	$831,300,000

Foreign Airlines

Air France	Boeing Type 707	10	
KLM Royal Dutch Air Lines	Douglas DC-8	8	
Japan Air Lines	Douglas DC-8	4	
Pan American-Grace Airways	Douglas DC-8	4	
Sabena Belgian World Airline	Boeing Type 707	3	
Scandinavian Airlines System	Douglas DC-8	7	
	Sub Total	36	$100,000,000
	Complete Total	**174**	**$931,000,000**

2—The choice of many airlines will be a kerosine type fuel because of its greater availability and safety, particularly if it continues to hold an economic advantage over JP-4 fuel. While the engines for jet transports have been designed principally for JP-4 or gasoline-type fuel, they can be converted to operate on a kerosine type fuel without basic change.

3—Aviation gasoline will remain in the commercial aviation picture for many years to come. Overall demand in the U. S. in 1955 is expected to reach its maximum since the war, about 238,000 b/d, and then decline despite the rise in civilian uses. Chief reason for the decline will be the falling off in consumption by military aircraft, as jets replace the present types. The present trend toward higher octane "avgas" is expected to continue, with more than half that used being above the 100/130 grade by 1965.

The volume of any type jet fuel for civilian requirements will not be much above 80,000 b/d by 1965, as at present estimated by various authorities. However, this civilian use, and the use of some kerosine-type fuel by the military, would be additional to other growing demands for a relative small cut from the barrel of crude the refiner processes, which may even in a few years include fuels for gas turbine-propelled automobiles.

The Boeing Airplane Co. has made volume projections through 1959, for both total kerosine demand and for JP-4 fuel, plotting its data from product forecasts by one large oil company. The Boeing estimate for JP-4 fuel demand by 1959, for both civilian and military use, is set at 280,000 b/d. Virtually all jet fuels used today are JP-4 type, the current composition being about 70% gasoline, 21% kerosine, and the rest distillate. The JP-4 specifications were drawn by the military to provide a product the supply of which could be greatly expanded in time of war.

The Boeing study brings out that in the event of such emergency, some 55% maximum yield of JP-4 fuel could be achieved from the average crude the refiner processes, by greatly increasing the proportion of kerosine and distillate oils in the fuel.

Kerosine demand for all uses by 1959 will be about 415,000 b/d, compared with 330,000 b/d in 1955, the aircraft company anticipates. While the volume of jet fuel of any type by 1959 will be small, if it were kerosine, it would be competitive with other specialized markets the refiners have developed for this product.

One oil company expects the total demand for jet fuel in the U. S. to nearly double from 1955 to 1965, and reach 410,000 b/d by 1965. Civilian domestic demand by then is expected to be about 20% of the total demand. This company states that at present a kerosine-type fuel seems to be desired by the majority of the airlines. However, if the airlines impose severe specifications on this type of fuel, there probably would be no economic incentive to use kerosine rather than JP-4 fuel. This company's estimates of U. S. demand for both jet and aviation gasoline through the postwar period to 1965 are those shown in the accompanying table.

Commercial Flying— A Changing Picture

Foretelling what is ahead, seven U. S. flag and six foreign flag airlines in the last three months of 1955

placed orders with American manufacturers for 174 jet transports of the type that will take up to a tank car and a half of fuel each time they fill their fuel tanks. The total cost of these ships is nearly $1-billion. Deliveries will start in 1958.

In addition to these, British and French aircraft builders are filling orders for some 31 more jets to be sold to foreign carriers.

Still more jets are under option in this country, and aviation authorities believe that purchases by the airlines of gas-turbine powered aircraft may average as much as $2-billion a year for the next five years. This figure includes the slower, but lower cost, turbo-prop planes (in which the gas turbine drives a conventional propeller instead of moving the plane by the thrust of a jet stream of hot gases). These planes will be more economical than jets on short runs and can still provide some of the basic advantages of the newer designs over piston-powered aircraft.

Capital Air Lines in this country and Trans-Canada already have Vickers-Viscount turbo-props in service. Eastern Air Lines has recently ordered 40 Lockheed Electra turbo-prop airliners.

No detailed tabulation is shown of the present turbo-prop picture. However, as of the end of 1955, approximately 418 of these planes were reported on order or actually in service by 26 different foreign and U. S. commercial airlines. The Electra, typical of American made turbo-props, will fly at close to 420 mph and carry 66 passengers. The Eastern Air Line's Electras are scheduled for service in 1958.

A high degree of competition among the airlines, both for prestige and for economies in operation, is the chief factor in bringing jet aircraft into commercial service much earlier than had been anticipated. As a result, oil companies' attention is being focussed on fuel and lubrication problems which had not originally been regarded as imminent.

Jet flying has already caught the public fancy. The turbo-props Capital now operates are the most popular of its flights. Other airlines offices are already being queried as to when they will have jet planes in the air.

From a long range point of view, the airlines are convinced that the operating cost per passenger-ton-mile will be lower with jets than with gasoline engined airplanes. This is believed in spite of the greater weight and higher fuel consumption of the jet.

The main reason for this is that jets, flying at around 600 mph., can make more trips and carry more passengers or freight than planes now in service. Boeing Airplane Co. states: "Based on today's costs, the jet transport is competitive with the contemporary, four-engine, piston-driven, gasoline transports down to 200-300 mile ranges."

Boeing points out that fuel represents one-third of the total cost of operating a modern aircraft, and that the price differential between aviation gasoline and jet fuel is increasing. It says the margin now is substantially greater than the 4-6¢/gal differential used in estimating airplane operating costs.

Another important aspect to the early transition to jet transports comes from what the aircraft and engine manufacturers have learned in studying the high power research and development programs the Armed Services are carrying out in this field. This knowledge and experience can be adapted to the building of planes for civilian use. The military jets are prototypes of those to be provided the airlines.

Piston type planes are not out yet however. Many of them will be operated for years to come. Orders are still coming to the manufacturers for piston engine equipment, to supplement and to replace planes now in service.

The small airlines, of which there are many in this country, can't afford the $5 to $6-million apiece jets at present. Their needs can be taken care of by presently available reciprocating engine aircraft. Too, not all the large airlines have as yet ordered jets, preferring to wait until experience has proved out their benefits.

What the Airlines and Engine Makers Say

Following is a brief summary of some of the comment received by PETROLEUM PROCESSING Editors from airlines and aircraft engine manufacturers on the subject of the future commercial aviation fuels:

American Airlines, A. F. Fontanelli, Director-Fuel: "We plan to use a kerosine type fuel in the engines which will power our Lockheed Electra turbo-prop aircraft . . . This fuel question is being reviewed with our major suppliers but is not in the expedite stage, since we anticipate no requirements until about August, 1958.

"Despite the use of a kerosine type fuel for turbo-prop aircraft, we wish to emphasize that aviation gasoline demand will not drop appreciably. On the contrary we believe that aviation gasoline requirements will continue to be as great or greater when considering the continued use of reciprocating engine aircraft for many years to come."

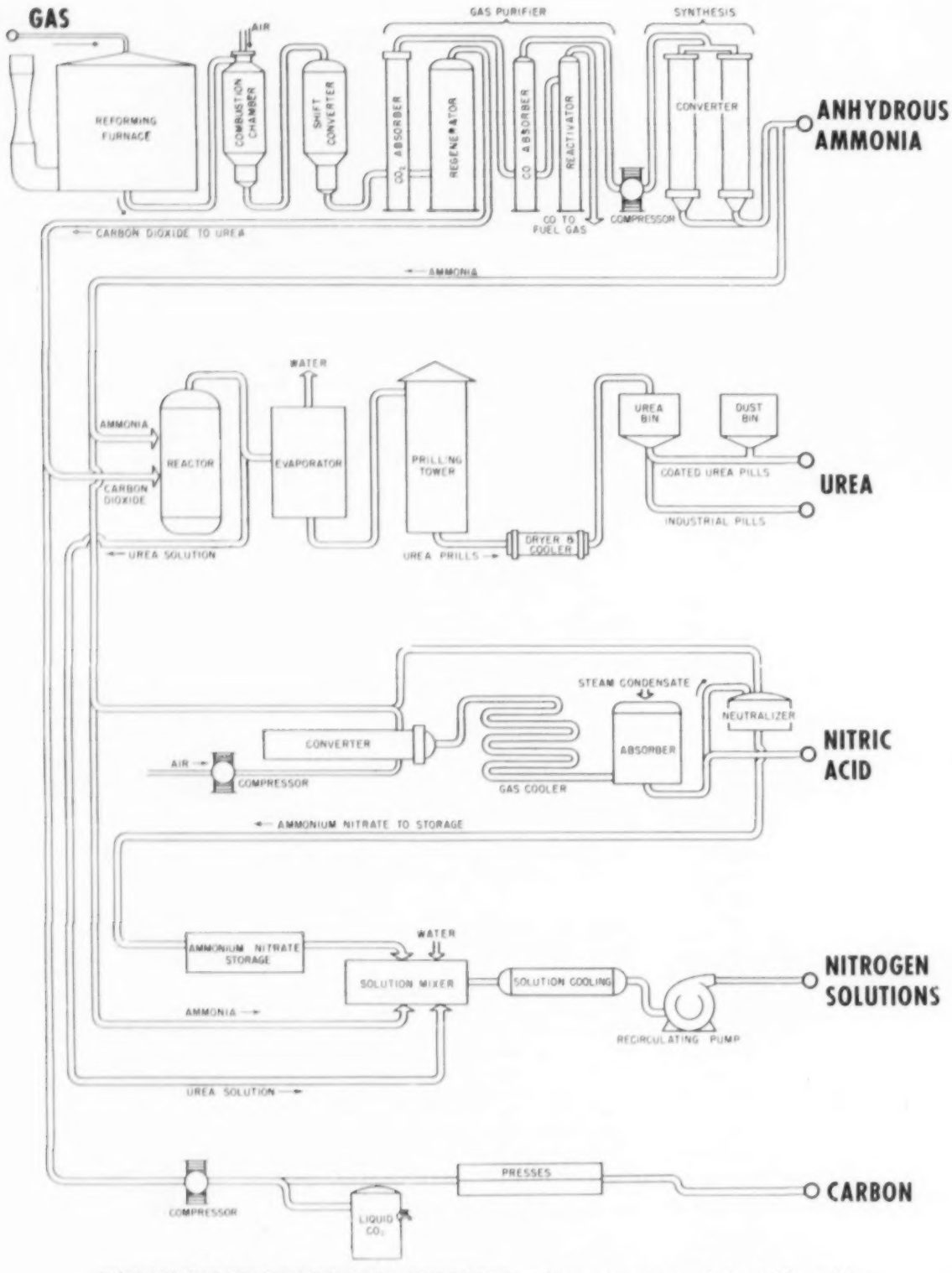
Pratt & Whitney Aircraft, Edward M. Benham, public relations manager: "With the gas turbine powered aircraft that have been ordered actually put into service, fueling them will be a standard function of commercial airports. As to the type of fuel that will be required, we believe it is too early in the program to release a specific formula. Undoubtedly the airlines will get together and establish a formula satisfactory to everyone."

General Electric Co., R. T. Lewis, manager, commercial aviation systems engineering: "Type of fuel to be used in the jet and turbo-prop transports at this time is highly debatable. The one positive fact is that it will be a distillate. Commercial applications seem to favor kerosine through its adaptability to reduce fire hazards. However, JP-4 fuel could be required if the engine were primarily designed for its use. At this point kerosine appears to have the popular vote and will probably be used by most operators.

Fairchild Engine Division, Fairchild Engine and Airplane Corp.; Emerson W. Conlon, assistant to general manager, Future Product Planning: "The fueling of gas turbine engines is already a standard function at some commercial airports and will steadily increase. The whole fuel subject is under intensive study by both the oil companies and the airlines. The fuel will probably be kerosine or JP-4."

Boeing Airplane Co.; R. L. Bell, director of sales: "Gas turbine engines will be adopted to such an extent that fueling them will be a standard function of commercial airports before 1960. These aircraft will require kerosine type or JP-4 fuel".

Aircooled Motors, Inc.; C. F. B. Roth, president: "The extent to which turbine type engines replace reciprocating engines in commercial aircraft will depend largely on economic factors. There will be gradual but constant increase in the ratio of turbine to piston engines in use as the former become less costly to produce, more economical to operate and more reliable in service. It is doubtful if any real development work to improve the competitive position of reciprocating engines for commercial aircraft will be undertaken."



FIVE MAJOR PETROCHEMICAL PRODUCTS and how they are made by Sohio at Lima

GENERAL VIEW of Sohio's ammonia plant at Lima, Ohio

How Sohio Makes Ammonia

. . . and derivatives, at new Lima plant, including first urea unit to be built using Inventa process

With the first shipments of products from Sohio Chemical Co.'s new $17-million plant at Lima, Ohio, in mid-December, the petroleum processing industry got a good look at another ammonia and nitrogen products plant in action.

And the industry also got a good look at the first urea unit to be built in this country using the Inventa process [Petroleum Processing, October, 1952, "New Urea Synthesis Process," by William F. Bland, pp. 1457-1460], developed by Holzverzuckerungs A.G. (Hovag) of Ems, Switzerland, an affiliate of Inventa A.G., Lucerne.

The Lima facility is the first petrochemical venture for Sohio Chemical's parent Standard Oil Co. (Ohio). When it reaches full-scale production about the middle of 1956, its products and design capacities will be:

Anhydrous ammonia	109,500 ton/yr
Urea	43,750 ton/yr
Nitric acid	21,000 ton/yr
Nitrogen solutions	70,000 ton/yr
Dry ice	27,400 ton/yr

The five process units and their interrelationship are shown in the schematic. A portion of the ammonia is channelled to the manufacture of nitric acid and nitrogen solutions, while a high purity carbon dioxide by-product will be used for the urea synthesis and liquid and solid CO_2. Construction is still under way on the CO_2 plant, and it is scheduled to go on stream in May, 1956.

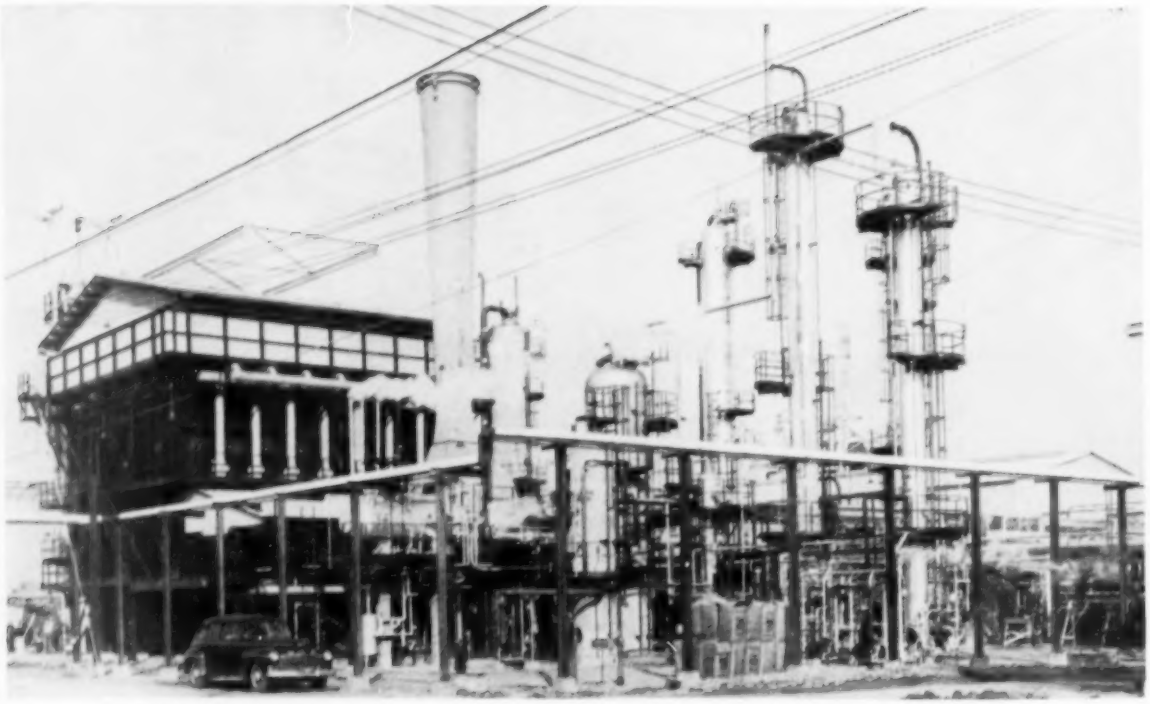
Ammonia Synthesis

The plant uses the M. W. Kellog Co. steam methane pressure reforming process. In the first step, desulfurized natural gas, and refinery gas from the Sohio refinery's catalytic reformer are converted to raw synthesis gas, which contains hydrogen, nitrogen, carbon dioxide, carbon monoxide, argon, and residual methane.

Although the natural gas is essentially sulfur-free, a desulfurizer has been provided to insure minimum sulfur content. The unit is of the bauxite and iron oxide contact type. The catalytic reformer gas is desulfurized by monoethanolamine and caustic scrub. The plot plan provides space for installation of a second MEA unit if required.

Gas feed then is reformed with steam over nickel catalyst in the pressure reforming furnace, with about 70% conversion. The balance of the conversion takes place in the combustion chamber, where the partially reformed gas stream from the furnace joins a stream of nitrogen (in the form of air) and passes downward through a bed of nickel catalyst. Heat of combustion of the oxygen in the air furnishes the needed energy for reforming, and elevates the gas stream temperature to approximately 1700° F.

As the mixture leaves the combustion chamber, its temperature is lowered by water spray in a quench chamber (not shown in diagram). This brings the temperature to the level required in the "shift" reaction and provides the steam required in that reaction.



BASIC AMMONIA UNIT, with furnace at left, sulfur removal equipment in right foreground

In this vessel, carbon monoxide in the mixture reacts with the steam over an iron oxide catalyst to form hydrogen and carbon dioxide. The gas is then ready for purification.

The next step, removal of the carbon dioxide for urea manufacture by a regenerative MEA system, has five advantages:

1—No oxygen contamination.

2—Negligible loss of synthesis gas.

3—Essentially complete CO_2 removal.

4—High purity product.

5—Compact equipment.

Compression for this step in the process is provided by a two-case centrifugal compressor, followed by two parallel reciprocating compressors, each with three stages. All these compressors are motor driven.

The bulk of the CO_2 is removed at the discharge pressure of the centrifugal compressor. Gas from the compressor passes through an aftercooler and thence to the bottom of the absorber, where counter-current extraction with an aqueous regenerative MEA solution takes out the CO_2.

Spent MEA from the absorber is heat-exchanged against hot stripped solution and passes to the top of a stripping column. Carbon dioxide stripped off passes overhead from a reflux drum. A portion of this CO_2 flows on to the urea unit. Lean solution from the stripper bottom is cooled by exchange with the rich MEA solution and is pumped back to the top of the absorber through a cooler. Two parallel, motor driven pumps are used.

Following this, traces of carbon monoxide are removed. Process gas overhead from the CO_2 absorber flows to the reciprocating compressors through a suction knockout drum. It goes through two stages of compression with intercooling and water separation between stages before entering the next purification step. Carbon monoxide and residual CO_2 are removed by treatment with a copper solution in the CO absorber, operating at 2100 psig., followed by contact with caustic in another scrubber.

Gas flows from this caustic tower through a suction drum to the third compression stage, whence it is discharged at 5000 psig. to the synthesis section.

The gas, containing hydrogen and nitrogen in a 3:1 ratio (volumetric) then feeds to a twin-converter system. It picks up recycle gas from the two recycle compressors and passes through an oil separator. This stream is then passed through an exchanger and an ammonia refrigerated chiller to a separator where liquid ammonia drops out as a product. This ammonia removes with it water of saturation carried by the fresh feed portion of the gas—an essential purifying function because all oxygen compounds, including water, are deleterious to the synthesis catalyst. The gas from the separator is heat exchanged against oil trap overhead to recover refrigeration, and it then flows to the converters.

Each converter consists of a high pressure shell containing a catalyst section and a heat exchanger. The catalyst section is a cylindrical shell inside the outer pressure shell, leaving an annular space between.

Catalyst is arranged in a series of beds, with provision made to inject cold feed gas as quench in the space between beds so as to maintain the catalyst at an optimum temperature for maximum yield. The top bed contains the smallest amount of catalyst to limit the temperature rise before the first quench point. Because the temperature gradient is flatter in succeeding beds, the bed sizes graduate up to the largest at the bottom.

Beneath the catalyst section is the heat exchanger for preheating fresh inlet gas against hot reacted gas coming down from the last catalyst bed. A by-pass tube through the center of the exchanger permits introducing

feed gas without preheating and provides means of controlling temperature to the top bed.

Normal feed entry is at the converter top. Gas flows down through the annular space, cooling the shell and being preheated prior to entering the exchanger. A portion of the stream may enter the bottom of the converter, by-passing the exchanger and meeting the preheated feed. The combined stream goes up the central tube and into the inlet of the first bed at the top. The gas then passes downward through the catalyst with a rapid temperature rise as the ammonia reaction proceeds, control being obtained as explained above, by cold fresh feed injection between beds.

Final ammonia product leaves the bottom of the converter, is cooled in an air-cooled unit, then against cooling water. A major portion liquefies and is separated from the gas. The separated gas passes back to the suction side of the recirculation compressors for return to the converters. A portion of the gas is vented as a continuous purge to control the concentration of methane and argon inerts. Otherwise these components would build up in the system reducing the pressure too low for effective synthesis, with resultant lower conversion per pass and production capacity.

MASS SPECTROMETER is used to check feedstocks and intermediate product streams at Lima

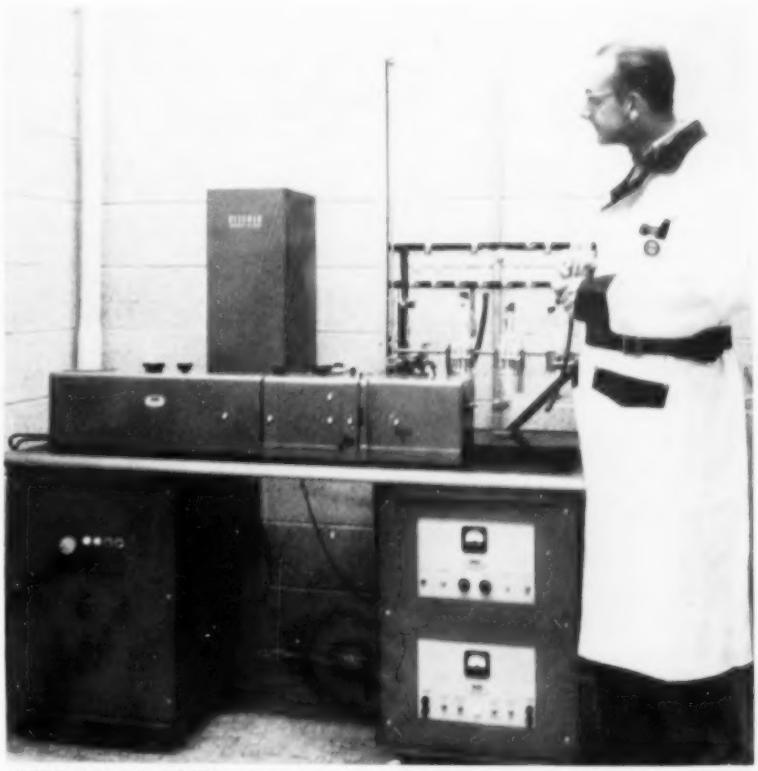
Nitric Acid

This unit, designed and built by Chemical and Industrial Corp., burns the ammonia and absorbs the oxides thus formed under approximately 100 psig. pressure.

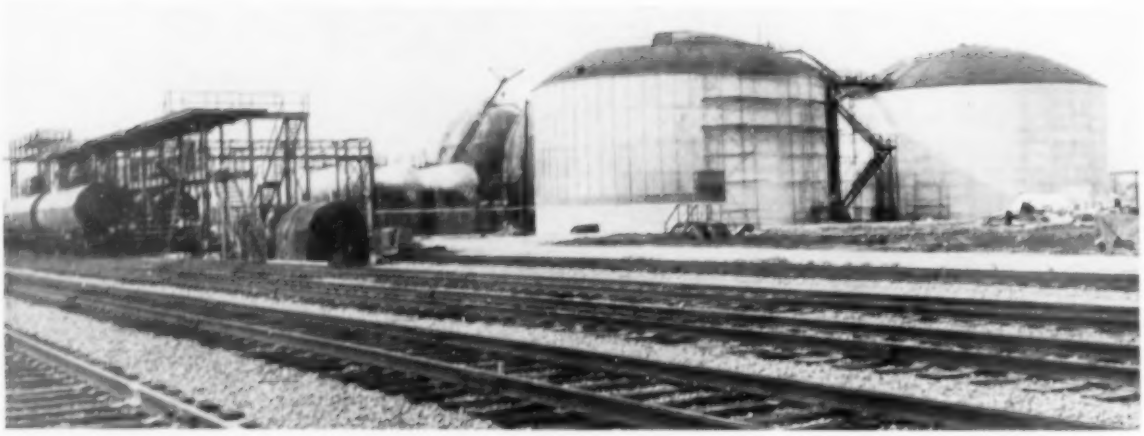
A mixture of air and ammonia enters a converter and burns in the presence of a platinum-rhodium catalyst. Resultant products—nitric oxide, vaporized water, and nitrogen—pass on through a heat exchanger. Here they are cooled by heating the exit gas stream to the expander turbine and the process air stream. Further cooling takes place in a waste heat recovery unit which generates saturated steam under pressure.

Cooling and oxidizing of the combustion gases—changing NO to NO_2—takes place in a multi-pass, horizontal, cascade type cooler. The acid condensed in this unit is delivered to a point in the side of the absorption column where acid strength of the acid inside the tower corresponds to that of the condensate.

Uncondensed gases—primarily nitrogen, NO_2, and oxygen—enter the base of the bubble plate absorption column and flow upward, counter-



INFRA-RED ANALYZER provides continuous monitoring of various process streams in the ammonia unit



AMMONIUM NITRATE PRODUCT IS HANDLED in special aluminum alloy tanks, loaded from rack at left to aluminum and stainless tank cars

currently to water (steam condensate) which is used as the absorption medium. Acid made in this column is swept by a stream of hot air and delivered to storage by the pressure existing in the column.

Nitrogen Solutions

Urea tail gas and ammonia purge gas are introduced into the neutralizer through submerged spargers. These gases supply approximately 80% of the ammonia gas required for neutralization: the balance is pure anhydrous ammonia. If the urea plant is not operating, 100% pure ammonia will be used for neutralization. Nitric acid enters through other spargers directly above those for the ammonia.

The resulting heat of reaction concentrates the solution to about an 83% ammonium nitrate. Water vapor from the neutralizer vaporizes the incoming liquid ammonia and then goes on to a direct contact scrubber where it is condensed by cooling water. Effluent condensate and the cooling water flows to the process sewer.

The 83% ammonium nitrate overflows from the neutralizer to another tank, where liquid ammonia is added to adjust it from an acid condition to a slightly alkaline condition. It then passes to run-down, then storage, and finally to the solution mixer.

In this baffled vessel, liquid anhydrous ammonia, the ammonium nitrate, and water are mixed in proportion which depend on the final ammoniated—ammonium nitrate solution desired. Automatic flow controllers, manually adjustable, regulate the respective rates of these materials. The resultant heat of the solution must be removed to prevent too great a rise in vapor pressure. This is accomplished by continuous recirculation of the mixer effluent stream through a shell-and-tube cooler at a rate sufficient to maintain temperature and vapor pressure as desired.

Urea

This unit was built by Vulcan Engineering Divisioin, Vulcan Copper & Supply Co. (which holds U.S. and Canadian license and rights on the Inventa process) as the prime contractor, and Arthur G. McKee Co. as subcontractor constructor.

The process overcomes two major production difficulties:

1—Extreme and rapid corrosion which usually occurs in the reactor, where ammonia and carbon dioxide form urea under high temperature and pressure.

2—The difficulty of separating the unreacted materials.

Certain features of the Inventa process have not yet been disclosed. Here is a brief description of the steps involved.

Liquid ammonia and gaseous carbon dioxide feed directly to the reactor. Under proper pressure and temperature conditions, two molecules of ammonia combine with one of carbon dioxide to form ammonium carbamate with the liberation of considerable heat. About half of the ammonium carbamate then dehydrates to form urea and water, at the same time absorbing a small amount of heat. The net product from the reactor is a liquid mixture of water, urea, and the carbamate.

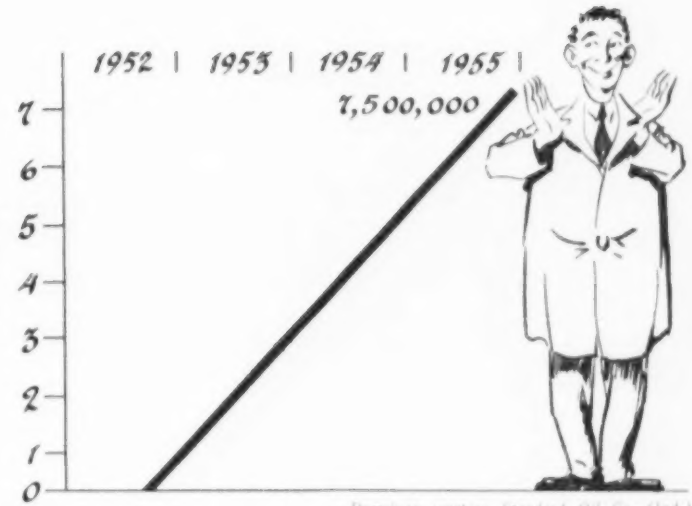
This mixture drops considerably in pressure and passes into the primary decomposer where most of the carbamate is decomposed to ammonia and carbon dioxide. After a further pressure reduction, a secondary decomposer removes practically all the remaining carbamate. The carbamate-free solution of urea and water is then concentrated in a vacuum evaporator and pumped to the top of a 120-ft prilling tower.

Prilling is nothing more than a new name for the old process of making buckshot. However, it has been developed considerably into a technique to produce uniform sized particles, or pellets. The hot, concentrated urea solution is sprayed at the top and the spray drops through a rising stream of cold air. During this procedure, spherical pellets take shape and solidify, coming out at the bottom of the tower in the form of small shot, or "prills." The prills are then dried, cooled, and screened to remove particles of improper size. Finally, they are dusted to prevent caking, and are then ready for packing in bags.

Usual commercial practice in urea plants in the past has been to use lead or silver linings for the reactor and other accessories to overcome corrosion.

In the Sohio unit, the reactor is lined with Hovag's patented alloy which is expected to last from 10 to 15 years instead of being replaced every year as has been the case with lead or silver.

The 83% ammonium nitrate solutions are stored in two special aluminum tanks of 35,000 bbl. capacity each. Sohio Chemical worked with the Aluminum Co. of America and Chicago Bridge & Iron Co. to develop these tanks. They are constructed of Alco Alloy 5052 for the sidewalls, and alloy 3003 for the bottoms. Welding was done by the consumable electrode process using alloy 5052 wire on sidewalls and 1100 for bottoms.



—Drawings courtesy Standard Oil Co. (Ind.)

NO LOST-TIME INJURIES in 7,500,000 man-hours at the Whiting Laboratories of the Research Dept. of Standard Oil Co. (Ind.) has broken all safety records for a petroleum or chemical laboratory—and the record is still growing

Indiana Standard proves . . .

Cooperative Safety Pays Off Big

. . . giving new laboratory safety record

By J. E. FRIDEN, Asst. Personnel Supervisor
Whiting Laboratories, Research Dept., Standard Oil Co. (Ind.)

THE beaming chemist in the lab coat at the top of the page has every reason to be proud. He represents 1200 scientists, engineers, technicians, operators, stenographers, and clerks who have built a new safety record at the Whiting Laboratories of the Research Department of Standard Oil Co. (Ind.). Their record of 7,500,000* man-hours worked without a lost time injury is the best in the files of the National Safety Council and American Petroleum Institute records for a petroleum or chemical laboratory and it is still growing. It is the result of what they call "cooperative safety."

Cooperative safety at the Whiting Laboratories means much more than having a few safety representatives who wear badges bearing the familiar green cross. It means that everyone is given the opportunity at one time or another to take part in inspecting equipment and laboratories and in advising fellow employees how to work more safely. It means attending regular meetings to be trained in the use of safety equipment, in first aid, and in all facets of safety, both at work and at home. It means being aware of the "safe way" at all times and telling others about it.

Active participation gets each employee to "think safety." It thus overcomes one of the greatest blocks in the path to an effective safety program. The supervisor can preach safety to the employee orally and in writing, he can furnish all types of protective equipment, and he can establish formalized safety training; but until he has each employee "thinking safety," there can be no real program. The eye injury because someone forgot to wear safety glasses and the acid-scarred hands because someone didn't think to wear rubber gloves are proof.

The Safety Organization

The accompanying chart shows the safety organization at the Whiting Laboratories. The administrative staff advises the technical staff, which actually administers the safety program.

Seven area safety committees are the heart of the safety program. Committee chairmen are generally non-supervisory professional men. The membership is made up of 50-60 non-supervisory people, both professional and non-professional. Members serve six-month terms, with one member usually carried over as the new chairman.

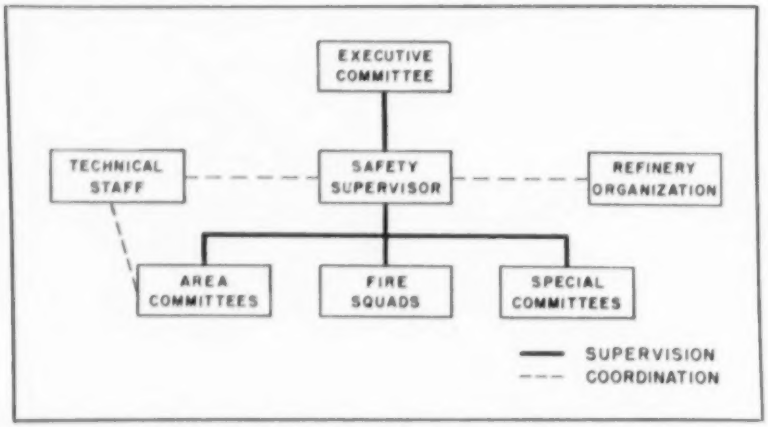
Fire squads composed of professional and non-professional personnel are also an integral part of the program. The members have been specially trained in techniques necessary to extinguish fires that individuals cannot handle. They also contain large fires until the Whiting Refinery fire department can reach the scene.

The safety supervisor guides and coordinates the program. This position is filled by men who have had experience on the professional staff. A background of this type makes for better understanding of the operating problems. A representative of the Whiting Refinery Safety Section serves in a liaison capacity to the safety supervisor to assure uniformity of practices. This is desirable because some of laboratories are within the adjacent refinery.

The Executive Safety Committee comprises top-level people of both technical and administrative groups. This committee renders only general policy decisions and believes in seeking specific solutions at levels close to the problems.

Close cooperation is maintained with the medical department. An in-

*Safety Figure as of Dec. 23, 1955.



LABORATORY SAFETY ORGANIZATION showing supervision and coordination channels

dustrial hygienist from that department makes frequent inspections for specific hazards, such as the presence of potentially harmful vapors. He recommends extra medical examinations, where necessary, for the personnel. The medical department maintains the main plant hospital in the refinery and a staffed first-aid room at the research laboratories.

Committee Operations

The area committee members make monthly formal inspections of their areas in addition to their day-to-day surveillance for unsafe conditions. A typical inspection covers subjects ranging from general housekeeping to the safe handling of rocket propellants on government contract work. The handling of laboratory glassware is as carefully inspected as the operation of full-scale engines on dynamometer test stands. The committee may concern itself with a canister gas mask in a laboratory or with a protective suit, complete with hood and rubber boots and gloves, such as is used for pilot-scale work with hydrofluoric acid.

The results of the formal inspections are discussed in meetings. Written reports of the findings and recommendations are distributed to the parties concerned and to all supervisors in the area. The more involved problems are discussed with the technical staff and with the safety supervisor. Monthly meetings of the chairmen with the safety supervisor assure exchange of ideas between the committees.

As needed, special committees are formed to inspect new equipment, such as pilot plants, and major revisions to existing equipment. These committees comprise the safety supervisor, the refinery safety representative, the equipment operator, the professional man in charge of the operation, and one or more professional people who are well versed in the type of equipment.

Because pilot plants are the forerunners of commercial units and process the same materials, they receive especially careful consideration before being operated. In their case, the inspection committees have no prior operating experience for guidance. Pressure ratings, relief valves and rupture disks, vent lines, check valves, and electrical equipment are among the features inspected. Detailed operating, emergency, and safety instructions are "musts." Suitable protective clothing must be provided and the operating area must have adequate fire protection equipment, safety showers, and eyewash fountains.

Recommendations of the special committees are usually few and minor, for the professional personnel are most conscious of safety and they work closely with the safety supervisor when planning new operations. For example, blueprints of new equipment are submitted to the safety supervisor for recommendations before construction begins.

Communication and Training

The representative of the Whiting Refinery Safety Section assists the safety supervisor in editing a monthly "Research Safety News Letter." The laboratory man at the beginning of the article is the custodian of the safety record graph in each issue. Another regular feature is "Harry Hazard," symbolic of all those who send chills down the spines of safety supervisors everywhere. The results of some of Harry's typical exploits are shown in cartoon form. The News Letter and booklets distributed to the employees stress safety, both at work and at home.

On-the-job saftey training is afforded by ample break-in periods for personnel on new operations, by operating manuals for specific equipment, by safety manuals for particular types of work, and by service on the safety committees. Not all safety can be taught on the job, however. Training sessions are held in fire-fighting techniques and equipment, operating and safety procedures designed for each area, and the use of special safety equipment, such as breathing equipment and fire-blanketing systems. The monthly area committee meetings include movies and talks on safety, first-aid instruction, training in the use of safety equipment, and other pertinent subjects.

Conclusion

The axiom, "one learns best by doing," has proved true in the safety program at the Whiting Laboratories. A new world record stands as evidence. Participation in the program by all employees has led to "cooperative safety," a better way of working —and living.

Meet the Author

Mr. Friden

Mr. James E. Friden joined the Research Department of Standard Oil Company (Indiana) in 1948 and has worked in the fields of pilot-plant development, administration of construction and maintenance, and personnel administration. For the past two years he has been safety supervisor for the Whiting Laboratories.

Born in Pittsburgh, Pennsylvania, but claiming the Adirondack Mountains of northern New York as his native habitat, he received his B.S.Ch.E. degree from Clarkson Tech and his M.S. in Chemical Engineering from Carnegie Tech. He served three years with the Naval Air Corps during World War II.

Mr. Friden is the author of several publications and patents and is a member of Omega Chi Epsilon and the American Institute of Chemical Engineers.

How an Oilman Can . . .

Take a 'Busman's Holiday'

By STUART D. BOYNTON
Assistant Editor

HAVE you ever wished you could get out to see more of your industry—new installations, important designers, or just men working on problems similar to yours? Probably, like many people, you don't get away very often and feel you don't have enough time when you do.

Probably, too, you've never worked systematically to take advantage of the chances there are. But you *can* see the world outside. And you will profit from your efforts to learn more in this way. "Busman's holiday" has come to mean following your usual occupation on your days off. Let's call this getting out to learn an oilman's holiday. Remember, it's a holiday calculated to move you up the ladder in your profession.

Here's what it can do for you:

- **Broaden your outlook.** It can put your industry, or your part of it, in the right perspective. It's valuable to see your operations through the eyes of others.
- **Keep you up to date.** You might want to learn first-hand about a new control system, a special pump for corrosive fluids, or talk with a man who has developed a new process. The value of keeping up with things in the industry—and of seeing it for yourself—hardly needs to be mentioned. But what you learn this way has another important use, and this is the next point.
- **Prime your "idea pump."** It has been found that people are most fertile with new ideas when their minds are thoroughly stocked with background information (see "How Ethyl Promotes Creative Thinking," PETROLEUM PROCESSING, Jan., 1956, pg. 54). Your ideas are one of the decisive factors in your success as an engineer.
- **Help you solve problems.** You never can tell where you may find the solution to that problem you are working on. A casual visit with an equipment supplier or with your counterpart in another oil company may put it in a new light. The busy hubub of a convention sometimes discourages this frank and informal exchange of ideas.
- **Make new contacts in industry.** The oilman's holiday is your chance to meet people important in your field, or just to make more friends outside your company. As their guest you are usually assured of a courteous reception and a real chance to talk.

When and Where to Go

If you agree that there is value in a carefully planned oilman's holiday, when and where do you go? When—while you are on a business trip for the company, at conventions, or on your vacation. The company has a lot to gain from the knowledge these trips can give you. A little selling to your supervisor could turn almost any trip away from the company into an occasion for an oilman's holiday.

What or who you see when you are traveling depends on the area you will be in, but use these possibilities as a checklist:

- Refineries, petrochemical and chemical plants, and research laboratories. These are the obvious first possibilties.
- Supplying industries: equipment manufacturers, engineering and construction firms, instrument designers and makers, producers of additives. These are important and would give you a chance to talk, as the user, to the manufacturer. Besides you can hardly fail to get willing cooperation from these people.
- People in your field at universities, private research companies, and consulting firms.
- Allied branches of the industry. In transportation, marketing and producing you can acquire valuable background or even pick up very pertinent information. Don't overlook the sources in your own company—the legal department, accounting, economics.
- Military installations. Extensive testing and development of petroleum products often takes place there.
- The end points of your end products—lubricants, chemical intermediates, etc.
- Auto and airplane engine manufacturers, business finance firms and the stock market, museums having special geology or petroleum production exhibits, and others.

What's in the Area?

Assume the occasion for your oilman's holiday is a convention or business trip. Once you know where you will be, you must hit your sources to see what you can learn on side-trips. Then, select the more interesting possibilities, begin to make contacts, and draw up an itinerary.

First, the sources. Where can you find which companies and people are in the area? Much of the best information can come from people in your company.

For instance, plant locations and personnel you should be able to get from the chief engineer, general superintendent, plant manager, or someone else high in manufacturing. The people in charge of purchasing can direct you to equipment suppliers. And the project engineers will know all the engineering and construction firms.

Some of the available published sources are shown in the accompanying table. These are not hard-to-get or little-known sources. Rather they are the standard directories every petroleum refinery should have access to

Where to Get More Information to Plan Your Busman's Holiday

- **For locating plants and chief personnel**
  "1955 Petrochemical Plant Directory," (U.S. and Canada), published by PETROLEUM PROCESSING
  "Directory of Plants and Personnel" (refineries, field processing plants and petrochemical plants in the U.S. and Canada), published by the *Oil & Gas Journal*
  "Thomas Register of American Manufacturing." Lists chemical and petroleum plants by state within over-all category of product
  "Industrial Research Laboratories of the U.S." (includes consulting research labs), published by the National Research Council. Has a geographical breakdown, but the last edition was in 1950

- **For locating suppliers of refinery equipment**
  "Composite Catalog for Refining, Natural Gasoline and Petrochemical Industries," published by Gulf Publishing Co. Incomplete, as it includes only advertisers
  "Chemical Engineering Catalog for Equipment, Engineering Services, and Materials of Construction," published by Reinhold Publishing Co. Material only for the chemical industry

- **For locating processes**
  "An Appraisal of Catalytic Reforming," published by PETROLEUM PROCESSING. Contains a geographical breakdown of plants with a cat reforming unit
  List of Houdriflow, Houdriforming, and Houdry dehydrogenation units. Published Dec. 8, 1955, by Houdry Process Corp., 1528 Walnut St., Philadelphia 2, Pa.

- **For locating schools and consultants**
  "Pattersons Educational Directory," published by Educational Directories, Inc.
  "Consulting Services," published by the Association of Consulting Chemists & Chemical Engineers

through the company library, trade publications, professional societies, or through the mails at little expense.

Set Up Your Visit

Assume you've found plants where you can learn something helpful in your work either near your destination or along your route. Here are the things to do before you can set up a final itinerary.

Who Is the Right Man?

If your interest is in refinery equipment rather than a certain man, you must still find the person best able to tell you about it and show you the pump, distillation tower, control system, or what have you.

People in your company may be able to suggest names. If not, do what you'll be doing later when you make arrangements: ask your department manager to write to his counterpart in the other company and request a chance for you to meet the right man.

Naturally, you must be careful about showing too keen an interest in things the other company regards as secret. Your superiors will be reluctant to help you with arrangements and the whole idea could backfire if you try to push your way into "sensitive" areas. Keep your curiosity within the range of subjects freely discussed among technical people in competing firms.

Even if you already know the man to see, you must still lay the groundwork for a meeting. A friendly letter outlining your proposal in detail is a good beginning. Mention that you will obtain approval of the visit from his company and your own. If he agrees to the idea, you should then start working through channels.

Everyone knows there are ways to get "behind the scenes" without going through channels for a person not burdened with prudence. But letting the right people know your intentions is the best way to avoid later embarrassment to your host and yourself.

So tell your supervisor what you want to do and when you are going to make the trip. Ask him to OK it and to contact the appropriate person in the other company. However he handles it from there, once the idea is approved you are assured of greater frankness from your host and perhaps of a more cordial reception.

This procedure is wisest even if you are on friendly terms with your host-to-be, though the arrangements he may offer to make in that case may be sufficient, depending on his company's policy.

The nature of your trip will determine how much time you'll have for these special visits. A realistic schedule will include no more than three visits in one day at a single plant. If there are two places to go, make it two visits.

Get the Full Value

Don't let the experience go stale once you've taken your oilman's holiday. You have met some people, perhaps for the first time, and learned things at first-hand from men who really know. Here are some ways to put all this to use.

- **Keep the contact alive.** Your host helped you, and now you may be able to help him. Send him any information you can about your mutual interest: meeting papers, your own ideas, trade magazine articles, speculations from people in your company. Make it a point to meet him again at trade conventions or when he is in your area.
- **Develop your new knowledge.** Talk it over with people in your company. Read what you can find on the subject.
- **Pass it on.** Here's where you can help others in your company as well as yourself. Write a report and submit it to your supervisor. Offer to speak about your visit at departmental or divisional meetings.
- **Be host yourself.** Offer to brief technical men visiting your plant on the subject, if this is appropriate to your operations. Ask the man you saw to visit you at your company when he can.

Here's Your Chance

YOU may soon have your chance to take an oilman's holiday, if you haven't up to now. The American Petroleum Institute Division of Refining will have its mid-year meeting in Montreal next May 14-17. Montreal is a major center of the Canadian refining industry.

Details of what Montreal has to offer are given in next month's issue. Read it and plan your "busman's" holiday for May.

Русский медведь говорит о своей работе

What? You don't know what that headline means? Well, translated literally, it is:

"Russian Bear Talks about His Own Work"

. . . by which we mean that the Russian technical man is talking shop these days and what he has to say, and how we might profit by it, is the subject of this valuable article.

By MARSHALL SITTIG
Larchmont, N. Y.

YOU should know what the Russians are doing.

With the partial lifting of the Iron Curtain, and with more information on technology coming out of the Soviet Union, this is a good time to see what can be learned about what the Russians are doing.

Petroleum is now the top Soviet export commodity—replacing grain, the 1954 leader. While Soviet oil production, estimated at 1,150,000 b/d, is low compared to U.S. oil production, Soviet interest is high in better and more efficient refining methods.

So let's take a look at the availability of information from the Soviet Union and how it can best be put to use. It is certain that Russia and her petroleum-based industry will be a powerful factor in world affairs. It matters little whether you consider Russia a potential consumer for your products, or a potential enemy—either way it is important to know what your counterparts in Soviet petroleum processing are doing and planning.

Why Study the Russian Language?

The quantity of scientific information coming from the Soviet Union is very large—in spite of the Iron Curtain. Russia is actually the third-ranking technical language, after English and German. Even around 1939, the number of Russian publications in chemistry, for example, exceeded those by the French.

Soviet books and magazines are available on the petroleum and chemical industries. Also available are magazines and books in fundamental scientific fields, giving information on heat transfer, fluid flow, hydrocarbon chemistry, thermodynamics, etc. Much can be obtained from these publications with only a little knowledge of the language—just enough to permit the translation of titles and subtitles, the captions and legends in illustrations, and an occasional brief summary or list of conclusions.

Some outside organizations translate articles and reports, while some companies use their own translators. But the number of people who combine a knowledge of Russian with a

The Russian Alphabet

Conventional Printed	Alphabet	Italics		English Transliteration
А	а	*А*	*а*	a
Б	б	*Б*	*б*	b
В	в	*В*	*в*	v
Г	г	*Г*	*г*	g
Д	д	*Д*	*д*	d
Е	е	*Е*	*е*	e
Ж	ж	*Ж*	*ж*	zh
З	з	*З*	*з*	z
И	и	*И*	*и*	i
Й	й	*Й*	*й*	i
К	к	*К*	*к*	k
Л	л	*Л*	*л*	l
М	м	*М*	*м*	m
Н	н	*Н*	*н*	n
О	о	*О*	*о*	o
П	п	*П*	*п*	p
Р	р	*Р*	*р*	r
С	с	*С*	*с*	s
Т	т	*Т*	*т*	t
У	у	*У*	*у*	u
Ф	ф	*Ф*	*ф*	f
Х	х	*Х*	*х*	kh
Ц	ц	*Ц*	*ц*	ts
Ч	ч	*Ч*	*ч*	ch
Ш	ш	*Ш*	*ш*	sh
Щ	щ	*Щ*	*щ*	shch
Ы	ы	*Ы*	*ы*	y
Э	э	*Э*	*э*	e
Ю	ю	*Ю*	*ю*	yu
Я	я	*Я*	*я*	ya

knowledge of the petroleum industry is small and the experts are few and far between.

Because this is the age of "do it yourself" let's look at the possibilities of acquiring a limited vocabulary of "petroleum Russian." This vocabulary may permit you to pick the essentials out of a Russian article, and help you decide whether a complete translation will be worthwhile. In any event, it will provide you with some mental stimulation—and that's always fun.

How Best to Learn Russian

The problem is how best to acquire a brief but useful Russian technical vocabulary. You've seen advertisements of Russian phonograph record courses. These are fine for conversational Russian, but not too helpful for translating written Russian—and particularly not for technical terminology. If you are fortunate enough to be able to take university courses—have the courses available and the time to take them—they are tops. Many of us have to—and *can* learn the useful essentials by self-study, however.

What Does the Language Look Like?

In addition to political obstructions, a powerful barrier to knowledge of what the Soviets are doing is the language difference. Just look at the word for petroleum for example. It is pronounced neft' and in Russian characters looks like this – **нефть.**

Now, let's look at some useful tools for acquiring a handy, useful group of Russian words—permitting us to learn a little more about what our Soviet counterparts are doing in petroleum processing.

The first tool is the Russian alphabet. It is shown above in all its glory—and all its complexity. As you can see, a number of letters which look like English letters unfortunately are not pronounced like their English counterparts:

- What looks like a *B* is a *V*
- What looks like an *H* is an *N*
- What looks like a *P* is an *R*
- What looks like a *C* is an *S*
- What looks like a *Y* is a *U*

The *A* and *E* and *O* are just what they look like. Then, however, there are a number of characters peculiar to the Russian. Some, like the *G* and the *F*, resemble Greek. This resemblance to Greek is somewhat natural because the Russian alphabet was invented by two Greek monks, Cyril and Methodius—the alphabet being known as the Cyrillic alphabet in honor of the one inventor.

A few letters have outstanding differences between the various forms of the printed characters and these are indicated by the color bands in the alphabet chart. Italics are important because author's names, tables of contents, and abstracts at the beginnings of articles in Russian journals are often printed in italics.

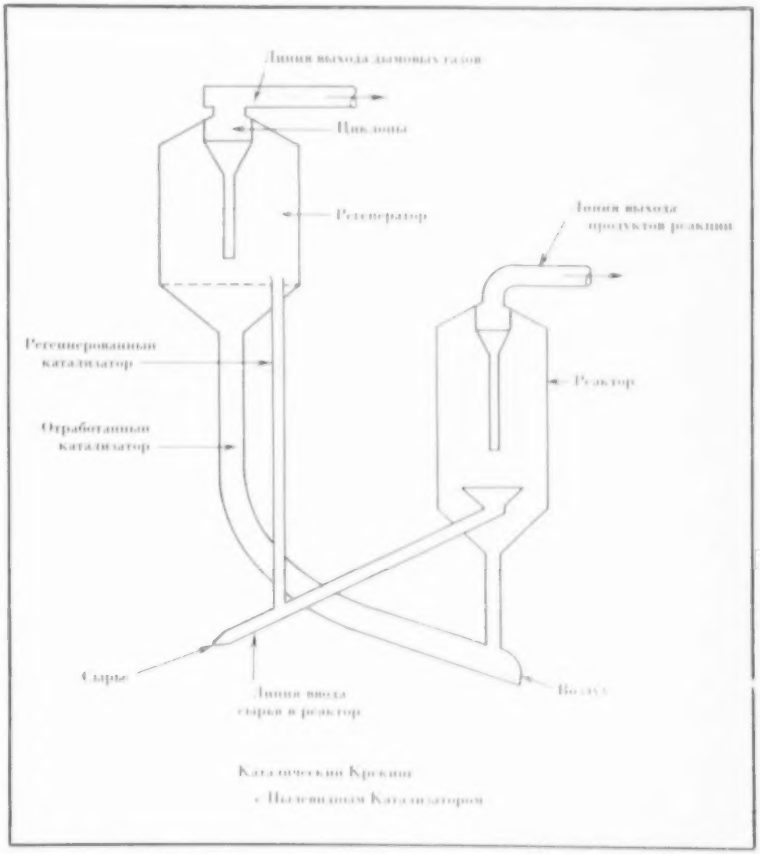
How to Acquire a Useful Russian Vocabulary

Here are a few specific suggestions for building up a useful vocabulary in "petroleum Russian":

1—Have at hand a glossary of those terms specifically useful to the field of petroleum processing. The accom-

panying table (pp. 58-59) gives such a glossary. It is suggested that it be mounted on stiff cardboard so that it can be propped up on your desk when you're scanning a Russian article. It will help you greatly if you will make a set of word cards from this glossary (plus any words particularly useful to you which are not included here), with the English word on one side of the card and the Russian word on the other.

2—Study flow diagrams and labelled photographs and sketches of known processes and equipment. This will help you to associate known objects with their Russian names. The drawing shows a Fluid cat cracker with the various pieces of equipment labelled in Russian. Look at it, try to pronounce the names, then try to prepare a similar sketch for your own processing unit and label the equipment from the glossary.



TRY YOUR SKILL—translate this Fluid cracker flow diagram

What to Do Next

The next things to do are to learn: (1) what books and publications are available from the Soviet Union, and how and where they can be obtained, and (2) what additional tools will give maximum access to the Russian books and publications we obtain.

First, let's look at how books and publications are made available by the Soviet Union.

There is an agency called **Международная Книга** or "International Book" with headquarters in Moscow and with outlets in all the countries of the world. This agency is the only official medium through which books and magazines are exported from Russia.

In the United States, there are two outlets, both with stores in New York City, and both doing mail-order business from these stores. One is the Four-Continent Book Corp. at 822 Broadway (at 12th St.), New York 3, N.Y. The other is Imported Publications and Products, 4 West 16th Street, New York 10, N.Y. Four-Continent has by far the largest supply of technical books available for inspection on the shelves in their store.

The only petroleum periodical currently available from these agencies is **Нефтяное Хозяйство** *(Petroleum Industry)* which covers the entire industry.

Each issue contains sections on Economics, Drilling, Production, Geology and Exploration, and on the Chemistry and Conversion of Petroleum and Gases.

Petroleum Industry is published monthly at an annual subscription rate of $7.00; the single issue price is seventy cents. The magazine has no exact counterpart in American magazines. In its contents it most closely resembles, perhaps, the British *Journal of the Institute of Petroleum Technology*.

Two articles in the section on "Chemistry and Conversion of Petroleum and Gases" in a recent issue described "The Testing of Rectification Columns With the Aid of Dilute Solutions" and "Heavy Aromatic Hydrocarbons in the Oily Fractions of Petroleum." As you can see from these titles, *Petroleum Journal* is a serious technical periodical. There are no personal or news notes—only technical articles, book reviews, and some reviews of foreign meetings and technical papers (such as the program of the recent World Petroleum Congress in Rome).

A journal formerly published in the Soviet Union (discontinued in 1941) was Azerbaidzhanskoe Neftyanoe Khozyaistvo or *Azerbaidjan Petroleum Industry*. This publication reported on the oil industry in the famous oil province of Azerbaidjan, where the city of Baku is located.

A chemical industry publication, **Химическая Промышленность**, *(Chemical Industry)* which somewhat resembles American and British trade journals has recently become available again with the lifting of the Iron Curtain. This publication has been missing from the export list for several years.

Both *Chemical Industry* and *Petroleum Industry* carry little advertising—a single advertisement of one British firm in *Petroleum Industry* and ads of two British firms in *Chemical Industry*.

Chemical Industry comes out eight times a year. The annual subscription price is $7.00 and the single-copy price one dollar. The magazine most closely resembles *Industrial and Engineering Chemistry* in this country—with the notable exceptions of more somber covers and layouts, and an almost complete lack of advertising.

The magazines mentioned above are industrial in character, like PETROLEUM PROCESSING. In addition to

Glossary of Common Petroleum

English Term	English transliteration of Russian term	Russian term
Absorber	absorber, poglotitel'	абсорбер, поглотитель
Absorption	absorbtsiya, pogloshchenie	абсорбция, поглощение
Acetylene	atsetilen	ацетилен
Acid	kislota	кислота
Additive	dobavka	добавка
Air	vozdukh	воздух
Alcohol	spirt	спирт
Aldehyde	al'degid	альдегид
Aliphatic	zhirnyi	жирный
Alkali	shcholoch'	щёлочь
Alkylation	alkilirovanie	алкилирование
Alumina	glinozem	глинозем
Amine	amin	амин
Ammonia	ammiak	аммиак
Antiknock compound	protivodetoniruyushchii material	противодетонирующий материал
Antioxidant	protivookislitel'	противоокислитель
Aromatic	aromaticheskii	ароматический
Asbestos	asbest	асбест
Ash	zola	зола
Asphalt	asfal't	асфальт
Barrel	barel	барел
Blending	smeshivanie	смешивание
Boiling point	tochka kipeniya	точка кипения
Bottoms	flegma	флегма
Burner	gorelka	горелка
Butadiene	butadien	бутадиен
Butane	butan	бутан
Carbon	uglerod	углерод
Carbon black	sazha	сажа
Carbon dioxide	uglekislyi gaz	углекислый газ
Carbon monoxide	okis' ugleroda	окись углерода
Catalyst	katalizator	катализатор
Catalytic	kataliticheskii	каталитический
Caustic Soda	yodkii natr	ёдкий натр
Charge	zagruzka	загрузка
Chemist	khimik	химик
Clay	glina	глина
Coke	koks	кокс
Column	kolonna	колонна
Compressor	kompressor	компрессор
Concentration	kontsentratsiya	концентрация
Condenser	kondensator	конденсатор
Control panel	kontrol'nyi shchit	контрольный щит
Conversion	pererabotka	переработка
Cooler	kholodil'nik	холодильник
Cooling tower	okhlazhdayushchaya kolonna	охлаждающая колонна
Cracking	kreking	крекинг
Crude oil	ciraya neft'	сырая нефть
Density	plotnost'	плотность
Desulfurization	desul'furizatsiya, obesserivanie	десульфуризация, обессеривание
Diesel fuel	dizel'noe toplivo	дизельное топливо
Distillate	destillat	дестиллат
Distillation	vozgonka, peregonka	возгонка, перегонка
Drum	baraban	барабан
Emulsion	emul'siya	эмульсия
End point	konechnyi moment	конечный момент
Engineer	inzhener	инженер
Equation	uravnenie	уравнение
Equilibrium	ravnovesie	равновесие
Ethylene	etilen	этилен
Extraction	ekstraktsiya	экстракция
Feed	pitanie	питание
Filter	fil'tr	фильтр
Flash point	tochka vosplamenenie, tochka vspyishki	точка воспламенение, точка вспышки
Flow	techenie	течение
Flue gas	dymovyii gaz	дымовый газ
Fraction	drob'	дробь
Fuel	toplivo	топливо
Furnace	pech'	печь
Gas	gaz	газ
Gas oil	gazoil'	газойль
Gasoline	benzin	бензин
Gravity	udel'nyi ves	удельный вес
Grease	smazka	смазка
Heat exchanger	teploobmennik	теплообменник
Heat of vaporization	teplota ispareniya	теплота испарения
Heat transfer	teploperedacha, teploobmen	теплопередача, теплообмен
Hydrocarbon	uglevodorod	углеводород
Hydrogen	vodorod	водород
Hydrogen sulfide	serovodorod	сероводород

these, there are a number of scientific journals, some of which are listed in the table.

A large selection of books on petroleum processing and on related fields of science and technology are available. A few of these are:

Переработка Нефти
Pererabotka Nefti (Conversion of Petroleum), by P. P. Karpov, 1953 ($1.50).

Практикум по Технологии Нефти
Praktikum po Tekhnologii Nefti (Handbook of Petroleum Technology), by I. P. Lukashevich and E. V. Smidovich, 1947 ($1.00).

Процессы и Аппараты в Нефтеперерабатывающей Промышленности
Protsessy i Apparaty v Neftepererabatibayuschchei Promyshlennosti (Processes and Apparatus in the Petroleum Industry), by G. G. Rabinovich and S. V. Adelson, 1949 ($1.25).

Most of the descriptions of equip-

Russian Technical Magazines and U. S. Counterparts

Russian Journal	Issues per year	Subscription price	Single issue price	American counterpart
Uspekhi Khimii (Progress in Chemistry)	8	7.00	1.20	Chem. Reviews
Zavodskaya Laboratoriya (Factory Laboratory)	12	13.50	1.35	None
Zhurnal Obshchei Khimii (Journal of General Chemistry)	12	16.50	1.65	J. Am. Chem. Soc.
Zhurnal Prikladnoi Khimii (Journal of Applied Chemistry)	12	14.00	1.40	Ind. Eng. Chem.
Zhurnal Fizicheskoi Khimii (Journal of Physical Chemistry)	12	24.00	2.40	J. Phys. Chem.
Izvestiya Akademii Nauk, Otdelenie Khimicheskii Nauk (Bulletin of the Academy of Sciences, Chemistry Section)	6	10.50	2.00	J. Am. Chem. Soc.

Processing Terms in Russian

English Term	English transliteration of Russian term	Russian term
Hydrogenation	gidrirovanie	гидрирование
Ignition	vosplamenenie, zazhiganie	воспламенение, зажигание
Index of refraction	pokazatel' prelomleniya	показатель предомления
Infrared	infrakrasnyi	инфракрасный
Inhibitor	ingibitor	ингибитор
Instrument	instrument, pribor	инструмент, прибор
Isomerization	izomerizatsiya	изомеризация
Kerosene	kerosin	керосин
Ketone	keton	кетон
Kinetics	kinetika	кинетика
Level	uroven'	уровень
Liquid	zhidkost'	жидкость
Lubricating oil	smazochnoe maslo	смазочное масло
Maintenance	obslushivanie	обслушивание
Melting point	tochka plavleniya	точка плавления
Mercaptan	merkaptan	меркаптан
Mesh size	mesha	меша
Miscibility	smesimost'	смесимость
Molecular weight	molekulyarnyi ves	молекулярный вес
Naphtha	nafta	нафта
Naphthene	naften	нафтен
Natural gas	prirodnyi gaz	природный газ
Octane number	oktanovoe chislo	октановое число
Odor	zapakh	запах
Oil	maslo	масло
Olefin	olefin	олефин
Oxidation	okislenie	окисление
Paraffin	zhirnyi	жирный
Petroleum	neft'	нефть
Pipeline	nefteprovod	нефтепровод
Polymerization	polimerizatsiya	полимеризация
Pour point	temperatura zastivaniya, tochka tekuchesti	температура застывания, точка текучести
Precipitate	osadok	осадок
Pressure	davlenie	давление
Processing	obrabotka	обработка
Product	produkt	продукт
Propane	propan	пропан
Pump	nasos	насос
Qualitative	kachestvennyi	качественный
Quantative	kolichestvennyi	количественный
Quenching	okhlazdenie	охлаждение
Reactor	reaktor	реактор
Recycling	pererabotka	переработка
Reflux	oroshenie	орошение
Reflux condenser	obratnyi kholodil'nik	обратный холодильник
Reforming	reforming	реформинг
Residium	osadok	осадок
Safety	bezopasnosti	безопасности
Sample	proba	проба
Scrubber	skrubber	скруббер
Six-membered ring	shestichlennoe kol'tso	шестичленное кольцо
Slide rule	schotnaya lineika	счетная линейка
Sludge	otstoi	отстой
Solubility	rastvorimost'	растворимость
Solvent	rastvoritel'	растворитель
Specific heat	teploemkost'	теплоемкость
Stack	dymovaya truba	дымовая труба
Storage tank	rezervuar	резервуар
Stripping	desorbtsiya	десорбция
Sulfur	sera	сера
Sulfur dioxide	dvuokis' sery	двуокись серу
Surface tension	poverkhnostnoe natyazhenie	поверхностное натяжение
Synthesis	sintez	синтез
Tank car	vagon-tsisterna	вагон-цистерна
Temperature	temperatur	температур
Tetraethyllead	tetraetilsvinets	тетраетилсвинец
Thermal	termicheskii	термический
Thermodynamics	termodinamika	термодинамика
Tower	bashnya	башня
Treating	obrabotka	обработка
Ultraviolet	ultrafioletnyi	ультрафиолетный
Unsaturated	nepredel'nyi	непредельный
Vacuum	vakuum	вакуум
Valve	klapan, kran, zadvizhka	клапан, кран, задвижка
Vapor pressure	uprugost' para	упругость пара
Viscosity	vyazkost'	вязкость
Viscosity index	indeks byazkosti	индекс вязкости
Volatility	letuchest'	летучесть
Wax	vosk	воск
X-ray diffraction	rentgenovskaya diffraktsiya	рентгеновская дифракция
Yield	vikhod	выход

ment and processes are comparable to current American practice. References to previously published work are confined almost entirely to mention of work by Russian investigators, however.

Now that we have some idea of what materials can be obtained in the Russian language, and of where they can be obtained, let's look at dictionaries and other tools for translation.

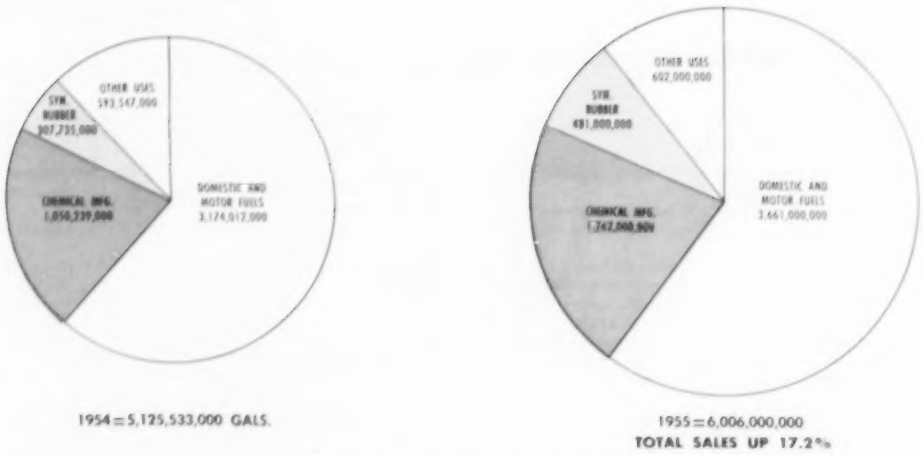
Without a doubt, the most useful dictionary is the "Russian-English Technical and Chemical Dictionary" by Ludmilla Callaham, published by John Wiley and Sons in New York in 1947 ($15.00).

A couple of useful publications are available from the U. S. Government Printing Office at the bargain rates which characterize most government publications. These are the "Dictionary of Spoken Russian," War Department Technical Manual 30-944 (November, 1945) and the "Glossary of Soviet Military Terminology," Department of the Army Technical Manual 30-544 (May, 1955) ($2.00).

For the reader interested in going beyond the dictionaries into Russian grammar, we might recommend the works of J. W. Perry, including "Chemical Russian, Self-Taught", published by the Journal of Chemical Education, Easton, Pa., (1948) ($3.00), as well as his more comprehensive "Introduction to Scientific Russian" which was published in 1950 by Interscience Publishers in New York ($10.00).

A final note on one aspect of Russian translation which holds much promise for the future—machine translation. The use of the IBM Model 701 computer as an electronic language translator has received much publicity. A recent book from the Technology Press at M.I.T. (published by John Wiley and Sons, 1955, $6.00) contains 14 articles on "Machine Translation of Languages" and discusses the machine translation of Russian specifically and in detail.

Machine translation is still being developed and is available to relatively few groups. Therefore, there is still great need for knowledge of language fundamentals and for use of the dictionary in conventional non-machine translation—so make some word cards and label a flow sheet you've made—so you can find out more about the Russian bear at work.



LARGER BITES out of sales pie for chemical and synthetic rubber uses meant . . .

Biggest LPG Boost in 33 Years

THE liquefied petroleum gas industry, sturdy offshoot of natural gas producing and petroleum refining, renewed its phenomenal growth in 1955.

Spurts in the use of LPG in chemical manufacturing and synthetic rubber manufacture pushed overall sales to an increase of 17.2% over 1954; the rise the previous year was 3.9%. Since World War II marketed production of LPG has more than tripled.

Total 1955 sales reached 6,006,000,000 gals. This was 880,467,000 gals. larger than sales the year before. Liquefied refinery gases supplied 30% of this production, and 70% was derived from natural gas.

Reduced to typical oil industry parlance, the total 1955 LPG volume figures out to nearly 392,000 b/d of marketed production.

The 1956 outlook is for another record growth for liquefied petroleum gas, with increased opportunities for refiners to share in the fast growing markets in synthetic rubber production and in chemical manufacturing. The rapid growth in complete weather conditioning (winter-heating and summer cooling) also offers opportunities for future sales and the smoothing out of the winter-summer sales ratio.

A market summary of the report for 1955 shows:

1—Sales for the manufacture of synthetic rubber components, under the stimulus of private ownership of the rubber plants, showed the largest gain in any single category, 56.3% larger than in 1954, for a total of 481,000,000 gals.

2—In chemical manufacturing, use of LPG outstripped the general upswing in the chemical industry by increasing 20.2% over 1954, total volume being 1,262,000,000 gals.

3—LPG used for domestic fuel purposes and as motor fuel increased 15.3% over 1954, the volume in this classification being 3,661,000,000 gals.

4—Industrial, gas manufacturing, and miscellaneous markets together increased only nominally in 1955 to 602,000,000 gals. The use of LPG in gas manufacture has dropped steadily for four years.

The supply picture: The liquefied petroleum gas industry continues to build up its potential producing capacity to meet large increases in market demand for its products. Twenty-two new plants, with total daily capacity of 850,000 gals., were put on stream in 1955. Twelve new plants are under construction or planned for 1956, with total capacity of 500,000 gals. daily.

Storage: Underground LPG storage building or planned is 292,000,000 gal. capacity, which will bring the total underground to 894,700,000 gal. This volume will be about one-seventh of the 1955 marketed LPG production. Conventional above-ground steel storage is also being increased.

Political: The pathway to federal regulation of natural gas production by the Federal Power Commission was opened through the important U. S. Supreme Court decision in the Phillips Petroleum case. The ruling already seems to be decreasing supplies of natural gas. If this trend is not halted by an act of Congress limiting the regulatory powers of FPC, dealers may be faced with shorter supplies and high prices.

Switch of the synthetic rubber plants to private ownership late in April, 1955, has put synthetic rubber production at a rate 17% above that of the first four months of the year. This is believed significant in showing that high production capacity can be achieved in the present plants, to meet the future larger demands for synthetic rubber. Some companies have already announced expansions of rubber plant capacity pointing to increased demand for LPG for synthetic rubber components.

A trend is developing in refining toward increased use of butylenes in the production of high octane motor fuels. A butylene shortage has already developed, which will become more critical as octane numbers are pushed higher. Thus, the manufacture of butadiene as a synthetic rubber component will depend more and more upon normal butane as its raw material, in place of butylene.

In chemical manufacturing, sales of LPG as a raw material showed a 20.2% increase over 1954, with an estimated volume of 1,262,000,000 gals. This compares with a rate of growth in the output of all chemicals in 1955 of around 11%.

An increased demand for ethylene has resulted in large volumes of LPG being used to supplant ethane as a base material for its manufacture. This trend should continue in 1956

as large ethylene and polyethylene plants now under construction are placed in operation.

New processes were highlights in the new uses for LPG in chemical manufacture developed during the year. These included new processes for the manufacture of glycerine and phenol from propylene, and the production of nitro paraffin and its derivatives, primarily from propane. Furthermore, propane and butane will probably remain for some time the most efficient and economic raw materials for oxygenated chemicals.

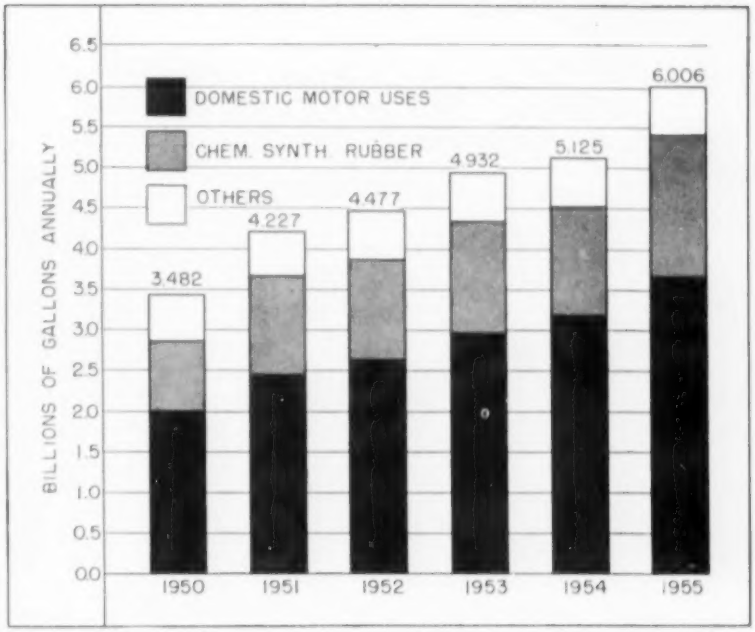
The combined chemical sales of LPG in 1955 combined with that going into the manufacture of synthetic rubber totaled 1,743,000,000 gals., nearly 30% of the entire LPG marketed production.

Biggest single use of LPG reported is combined household and motor fuel market, which was 3,661,000,000 gals. in 1955, an increase of 15.3% from 1954. It is estimated that 671,000,000 gals. of this total represents use in internal combustion engines.

House heating, the biggest single factor in the domestic market, is spreading rapidly northward as people become acquainted with the convenience and cleanliness of this fuel. Central heating is on the upswing, especially in the newer housing units. Summer sales of LPG are improving, for such uses as tobacco curing, crop irrigation, weed burning and control and other purposes.

Gains in motor fuel use of LPG were significant in all parts of the country in 1955. Biggest users are trucks, tractors, buses, and irrigation and drilling engines.

There are now over 250,000 LPG tractors in the U. S. Truck fleet operators are changing to LPG as service station facilities become more numerous and accessible.



CHANGES AND SHIFTS have been a pattern of LPG sales growth

This fuel is also finding a new use in industrial tractors and lift trucks, due to the fact that maintenance is reduced and there are less noxious odors in LPG engine exhaust.

Aircraft and auto manufacturers, airlines, steel mills, food processors, chemical plants, and lumber mills are a few of the larger industries which are converting their materials handling equipment to LPG.

Use of this fuel for irrigation pumps continues to increase in spite of the advances made by natural gas in this market. A survey of irrigation wells in the high plains area of Texas showed 46% used LPG, 35% used natural gas, and the remained used either gasoline, diesel fuel or electricity.

Industrial and miscellaneous uses for LPG totalled 431,000,000 gals. in 1955, an increase of 7.3% over 1954.

One new market is its use in uranium refinery operations. Stand-by plants are being added to take advantage of interruptable rates and as a protection against winter shutdown. The use of LPG in gas manufacturing, a relatively small market, decreased 10.9% in 1955 due to the competition of natural gas.

The preceding article is based on the annual statistical report on liquefied petroleum gas sales sponsored by the Phillips Petroleum Co. which has become a feature of the published literature of the LPG industry. The 1955 report was prepared by George R. Benz, manager, engineering department, Paul W. Tucker, technical representative, engineering department and W. F. De Voe, assistant to the sales manager, all of the Phillips Petroleum Co., Bartlesville, Okla.

Principal Uses of Liquefied Petroleum Gas

(1000 Gallons)

Year	Total	% Change	Domestic & Motor Fuel*	% Change	Indus. Misc.	% Change	Gas Mfg.	% Change	Chem. Mfg.	% Change	Synthetic Rubber	% Change
1951	4,227,275	21.4	2,456,804	21.6	269,408	**	281,692	11.9	844,501	35.2	374,864	64.1
1952	4,477,379	5.9	2,636,736	7.4	338,959	26.0	259,697	— 7.8	870,990	3.1	370,997	— 1.1
1953	4,932,009	10.2	2,977,418	12.9	374,233	1.04	222,430	—14.4	967,427	11.1	390,501	5.3
1954	5,125,533	3.9	3,174,012	6.6	401,615	7.3	191,932	—13.7	1,050,239	8.6	307,735	—21.2
1955	6,006,000	17.2	3,661,000	15.3	431,000	7.3	171,000	—10.9	1,262,000	20.2	481,000	56.3

*Household use plus other requirements such as irrigation, pumping, tractor fuel, flame weeding, chicken brooding and similar uses. Included also is LPG sold by domestic distributors but used for industrial purposes; also LPG sold direct by producers and marketers solely for fueling internal combustion engines.

**Not comparable due to change in method of reporting LPG sold for refueling internal combustion engines.

REMARKS: Total sales except for 1955 were obtained from Bureau of Mines data, also distribution for years 1951 to 1954, inclusive. All other volumes are estimates by the authors of the report. The total sales volume includes all LPG (propane, butane, and propane-butane mixtures) when sold as such. It does not include butane when blended with heavier petroleum fractions for motor gasoline purposes. Intercompany sales transactions, such as purchases of LPG by one company from other companies and resold as LPG have been eliminated.

1 Lowered into the waters of Ras Tanura

2 Towed one and a half miles to dockside

Water and Wheels

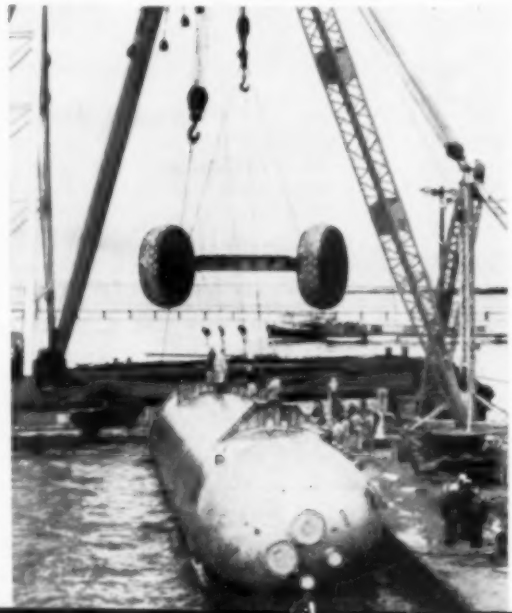
Deliver reforming reactor safe and sound

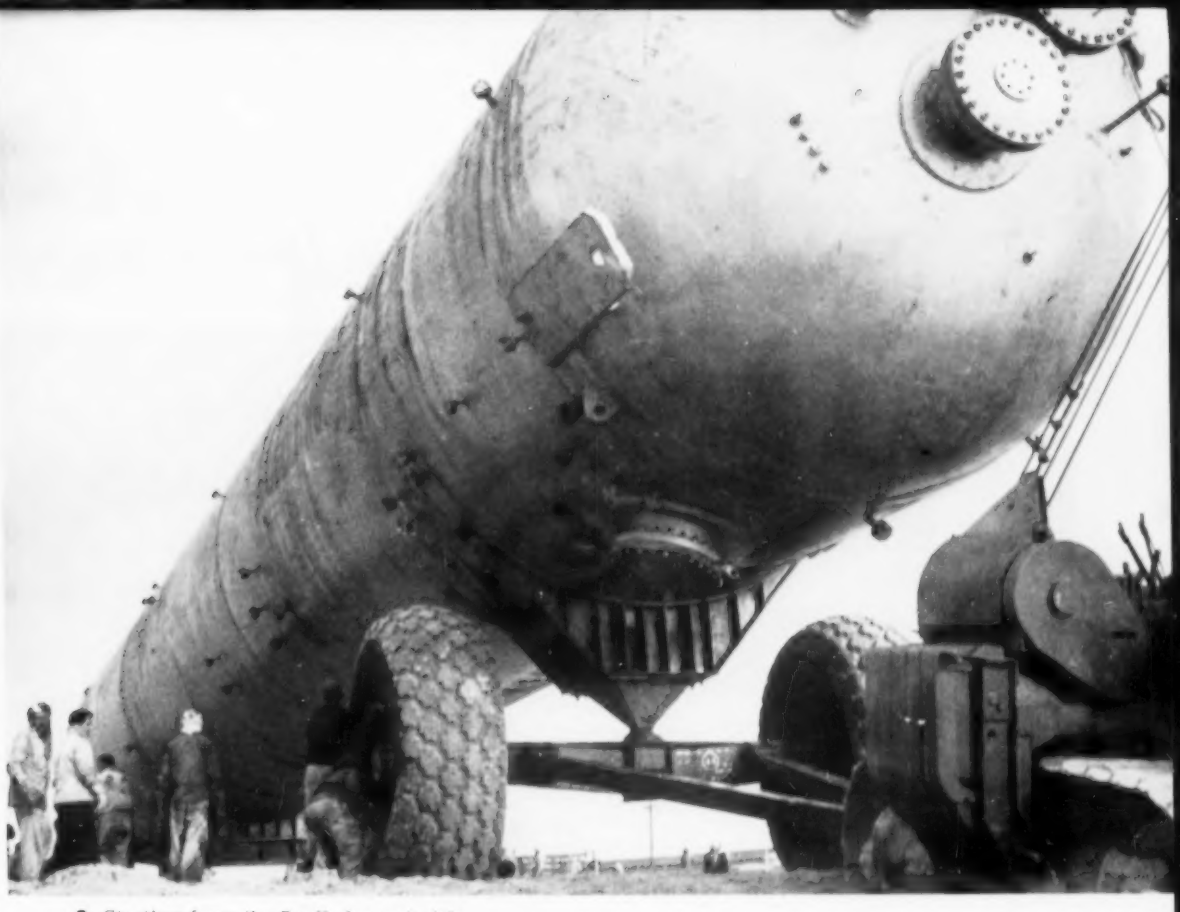
THE men floating along on Aramco's "vessel" seem casual about their contribution to an extraordinary odyssey. The reactor they are riding was brought to Ras Tanura, Saudi Arabia, after an 8,000-mile journey from the Netherlands. It was then trundled 7 miles cross-desert to its new home.

The 114-ft. vessel is now part of a Lummus-designed 12,500-b/d Fluid Hydroformer now on stream at Arabian American Oil Co.'s Ras Tanura refinery.

Only two of the world's freighters were capable of handling the 200 ton unit which had to be shipped on deck. Lowered into the bay by the ship's own jumbo boom, it was towed 1½ miles to dockside where special 10 ft. tires were welded on. It was then rolled over, moved to a sloping beach and towed ashore.

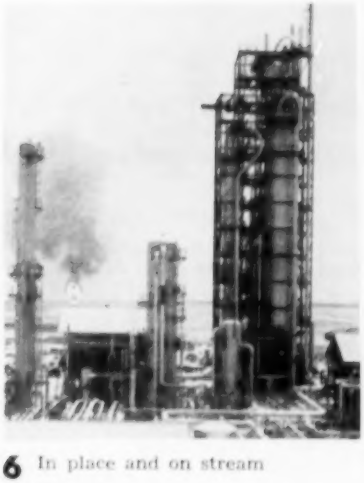
3 Ten-foot wheels being attached





4 Starting down the 7 mile homestretch

5 Special rigs position vessel



6 In place and on stream

New Process Design Methods for

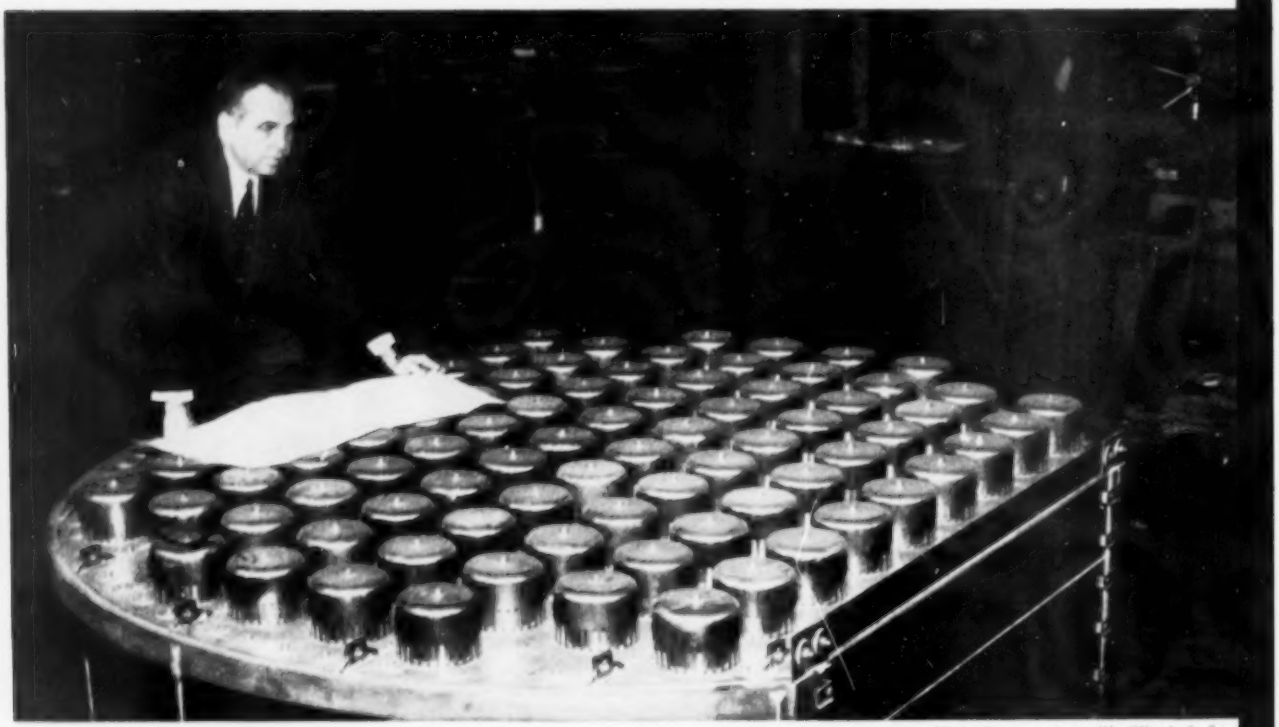


Photo Courtesy Fritz W. Glitsch & Sons

Beginning, in a 4-part series, the first complete process design manual for bubble-cap trays. The author gives new design concepts and methods, as well as recommendations for standardization in a highly unstandardized field. Based on extensive experience and study, he shows how to design bubble-caps and trays for optimum efficiency, giving greater flexibility and more capacity per unit area than possible by former design methods.

Meet the Author

Mr. William L. Bolles, manager of process design at Monsanto Chemical Co., Texas City, Texas, received a B.S. in Chemical Engineering from Washington Univ., 1941, and an M.S. in Ch.E. from Missouri Univ., 1943. He was with Socony Mobil Oil Co. in Dallas, Texas, and Paulsboro, N.J., 1943-47. Since 1947 he has been with Monsanto at St. Louis and Texas City, with the exception of 1951-52 when he was editorial director for the *Petroleum Refiner*.

An active member of the American Institute of Chemical Engineers, he has served on several national committees, and has just been elected Chairman for the South Texas section for 1956. Also, he is a member of the American Chemical Society, Tau Beta Pi and Sigma Xi.

Mr. Bolles, an active Kiwanian, serves on the Club's Texas City board of directors. His hobbies are music, he is an accomplished pianist and organist, and amateur radio, with call letters of W5GDF.

He and Mrs. Bolles make their residence in Texas City with their two children.

Optimum Bubble-Cap Tray Design

PART I–TRAY DYNAMICS

By WILLIAM L. BOLLES, Mgr. of Process Design
Monsanto Chemical Co., Texas City, Texas

BUBBLE-CAP trays are not obsolete, in spite of the views of proponents of other recently developed tray types. These new trays are usually claimed to yield higher capacities, thereby permitting savings in capital cost. Sometimes such claims are backed up by an example comparison against a bubble-cap tray. However, such comparisons usually present the bubble-cap tray unfavorably in that it is sized by old-fashioned design methods.

Recently, in some segments of the process industry, there has been a return to bubble-cap trays. This has resulted partly from the development of new design techniques which have increased bubble-cap tray capacity, so that bubble-cap trays are now competitive in cost with the new tray types. The deciding factor, however, has been the realization that the bubble-cap tray possesses certain advantages not available in any other tray type. These include: (1) higher plate efficiencies, (2) maintenance of high efficiency under wide load variations, (3) ability to handle wide ranges in vapor-liquid ratio, and (4) greater immunity to fouling and plugging. These advantages add up to more *dependable* all-around performance.

Even if the bubble-cap tray cost is slightly higher, it should be remembered that towers represent only a small fraction of the average plant cost. Consequently any added cost of bubble-cap columns expressed as a percentage of total plant cost is almost negligible.

The reader may well ask, why yet another article on bubble-cap tray design? There have already been a considerable number of publications on this subject, presenting some rather complete design methods.[2,5,10,16,18,19,25] However, the previous literature is not entirely satisfactory. The information required by the process designer is widely scattered, there being no one complete source. Many of the calculation methods previously available are rather cumbersome to use. Also, there has been very little published in regard to bubble-cap design. Further, the technique of determining optimum cap layout has been neglected.

Purpose of These Articles

It is the purpose of these articles to present a complete process design manual for bubble-cap trays. An attempt will be made to provide a logical approach to the selection of every tray factor.

New simplified but reliable methods will be presented for the estimation of pressure drop and liquid gradient. The first method for determining optimum bubble-cap design will be developed. Also for the first time, a set of standard bubble-caps will be proposed for general use. Also first presented will be an approach to the determination of optimum cap size and spacing. This will be accompanied by new techniques for optimum tray design. Finally, there will be a plea for return to a rational approach to entrainment.

At the outset, it should be made clear that the scope of these articles includes only the *process design* of bubble-cap trays employing round, bell-shaped bubble-caps of conventional design. For a discussion of the *mechanical design* of bubble trays, the reader is referred to the excellent discussion by Davies.[10]

There are many advantages to be gained through use of the new design methods to be presented. Previous reliable design methods were so laborious that few designers had the patience to experiment with more than one or two tray layouts. The new methods, on the other hand, are so convenient the designer can easily investigate the effect of all important tray layout variables, particularly bubble-cap size and design, cap spacing, skirt clearance, and tray type.

In spite of their convenience, the new methods to be presented are as reliable as present knowledge permits. The new methods are basically conservative, as has been found by experience in the design of scores of commercial fractionators. However, in order to inspire confidence, comparisons will be made between the new and the older, more familiar methods.

The design methods to be presented apply to all countercurrent, vapor-liquid contacting processes. This includes distillation and fractionation towers, absorption towers, and stripping towers.

In assembling this manual on bubble-cap tray design, it became clear that there remain some glaring gaps in bubble-cap tray technology. This is particularly true in regard to (1) quantitative prediction of foaming in downcomers, (2) prediction of amount of entrainment, and (3) prediction of plate efficiency.

It also became clear that the publication of complete performance data on commercial bubble-tray fractionators has been extremely meager, the principal exceptions consisting of Brown and Lockhart;[3] Cicalese, et al.;[8] Clay, Hutson, and Kleiss;[9] and May and Frank.[17] A plea is made here for encouragement of publication of performance data on commercial bubble-cap tray fractionators in order that our knowledge of this important process equipment can be extended.

Preliminary vs. Final Designs

Bubble-cap tray designs are of two major types: (1) preliminary designs for cost estimates, and (2) final designs for construction. Preliminary designs for cost estimates usually require only the approximate tower diameter, and the tray spacing or tower height. For this purpose a method previously published[23] is recommended. This method is based on a consideration of vapor velocity and liquid capacity. The results are usually conservative

Table 1—What the process designer should specify

A. Materials of construction
B. Type of tray
C. Bubble-cap design
- 1. Type and shape
- 2. Wall thickness
- 3. Caps
  - a. Diameter
  - b. Height
  - c. Number of slots
  - d. Slot dimensions
  - e. Height of shroud ring
  - f. Skirt height to be provided
- 4. Risers
  - a. Diameter
  - b. Height
- 5. Method of assembly and fastening

D. Downcomer design
- 1. Type
- 2. Number
- 3. Tray spacing
- 4. Downflow baffle clearance above tray
- 5. Restriction of tray support rings

E. Tray design
- 1. Column diameter to fit
- 2. Overflow weirs
  - a. Location
  - b. Type
  - c. Length
  - d. Height
  - e. Notch design (if employed)
  - f. Adjustable range
- 3. Other weirs
  - a. Inlet weirs
  - b. Intermediate weirs
- 4. Cap layout
  - a. Number of caps
  - b. Number of rows normal to flow
  - c. Cap pitch and spacing
  - d. Minimum cap clearances
    - 1) To weirs
    - 2) To downflow baffles
    - 3) To tower wall
- 5. Distribution baffles
  - a. Number and location
  - b. Height
  - c. Clearance to caps
- 6. Drain holes
  - a. Number
  - b. Location
  - c. Size
- 7. Design tray deflection
- 8. Listing or packing

F. Construction tolerances
- 1. Tray levelness
- 2. Weir levelness
- 3. Tray leakage

G. Special features

and sufficiently reliable for cost estimates.

The final design of bubble-cap trays for construction is another matter. Here every tray design factor must be considered. However, the *process requirements* of a good bubble-tray may be reduced to four simple characteristics, *viz:*

1—High liquid and vapor capacity
2—High plate efficiency
3—Low pressure drop
4—Ability to handle wide ranges of loads

The problem is that it is impossible to achieve simultaneously all of the above characteristics. Some of these characteristics can be obtained only by sacrificing in others. This problem can be resolved, however, when it is realized that the optimum tray design is that compromise which gives:

1—Minimum capital cost, and
2—Minimum operating and maintenance cost

In final designs, the process designer should specify all components which affect the process of fractionation. A check-list of these components for reference has been compiled in Table 1.

Tray Dynamic Calculations

In order to achieve an optimum balance of the process requirements outlined above, tray dynamic calculations should be made to determine:

1—Slot opening
2—Liquid height over weir
3—Liquid throw over weir
4—Liquid gradient
5—Dynamic slot seal
6—Vapor pressure drop
7—Vapor distribution
8—Liquid height in downcomers
9—Liquid residence time in downcomers
10—Entrainment
11—Plate efficiency

Fig. 1 illustrates the principal factors involved in tray dynamics. In this diagram the liquid is shown entering the tray at the left by means of the downcomer from the tray above. The height of material in the downcomer consists of the height of clear liquid plus the depth of the foam suspended on the surface. The liquid flows under

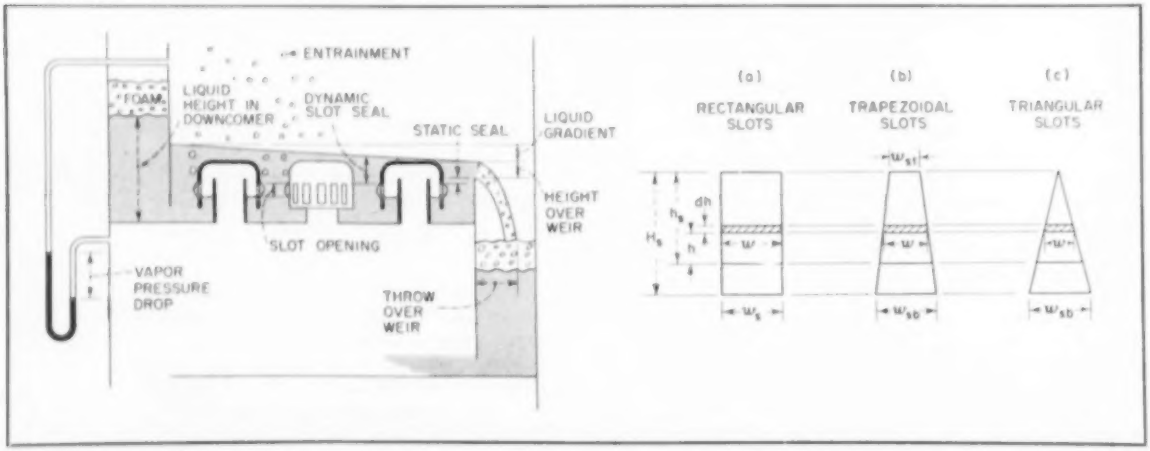


Fig. 1—**TRAY DYNAMICS** schematic diagram

Fig. 2—**SLOT OPENING FORMULA** derivation diagram

Nomenclature

a_a = Annular area per cap, sq. in.
a_c = Inside cross-sectional area of cap, sq. in.
a_r = Riser area per cap, sq. in.
a_s = Slot area per cap, sq. in.
a_{os} = Open slot area per cap, sq. in.
A = Area, sq. ft.
A_d = Minimum area under downcomer, sq. ft.
A_f = Available flow area, tower area — 2 x downcomer area, sq. ft.
A_r = Total riser area per tray, sq. ft.
A_s = Total slot area per tray, sq. ft.
A_t = Total tower cross-sectional area, sq. ft.
A_w = Total weep hole area, sq. in. per 100 sq. ft. tray area
c = A constant
C_d = Liquid gradient factor
C_s = Coefficient in maximum slot capacity formula
C_v = Vapor load correction factor
C_w = Wet cap pressure drop correction factor
d_c = Inside diameter of cap, in.
d_r = Inside diameter of riser, in.
D_t = Tower diameter (ID), ft.
e = Liquid entrainment ratio, mol/mol dry gas
E_d = Local dry plate efficiency, fractional
E_o = Overall plate efficiency, fractional
E_w = Local wet plate efficiency, fractional
F_w = Weir constriction correction factor
g = Acceleration of gravity, ft./sec.^{2}
G = Vapor mass velocity based on total column cross section, lb./hr.-sq. ft.
G_e = Liquid entrainment mass velocity based on area A_f, lb./min.-sq. ft.
h = Head or height, in.
h_c = Cap pressure drop (riser, reversal, annulus, slots), in. liq.
h_c' = Dry cap pressure drop, in. liq.
h_d = Liquid head loss under downcomer, in liq.
h_{ds} = Dynamic slot seal, in.
h_f = Distance of liquid free fall in downcomer, measured from weir, in.
h_l = Depth of clear liquid on tray, in.
h_{lo} = Depth of clear liquid at overflow weir, in.
h_n = Depth of notches in weir, in.
h_{ow} = Height of liquid crest over weir, in.
h_p = Partial cap pressure drop (riser, reversal, annulus), in. liq.
h_r = Pressure drop thru risers, in liq.
h_{ra} = Pressure drop thru reversal and annulus, in. liq.
h_s = Slot opening, in., or slot drop, in liq.
h_s' = Pressure drop through dry slots, in. liq.
h_{ss} = Static slot seal, in.
h_t = Total vapor pressure drop per tray, in. liq.
h_w = Height of weir above tray floor, in.
H_d = Height of clear liquid in downcomer, in.
H_s = Slot height, in.
K_c = Constant in cap partial pressure drop equation
K_s = Slot orifice coefficient
K_s = Constant in Souders and Brown entrainment correlation, ft./hr.
K_w = Ratio of weir length to tower diameter, l_w/D_t
l = Total free width between caps normal to flow, in.
l_r = Total free width between risers normal to flow, in.
l_w = Length of weir, taken straight across top, ft.
L_h = Volume of liquid hold-up per tray, cu. ft.
L_w = Total flow width across tray normal to flow, ft.
m = Exponent in entrainment equation
n = Number of liquid stages in series
N_c = Number of caps per tray
N_r = Number of rows of caps normal to flow
N_s = Number of slots per cap
N_t = Number of trays in column
Q = Liquid load for tray or tray section, gpm
R = Reflux ratio, mol liq./mol vap.
R_e = Entrainment quotient = eE_d/R
R_s = Trapezoidal slot shape factor, w_{st}/w_{sb}
R_v = Vapor distribution ratio
s = Cap skirt clearance, in.
t = Time, sec.
t_w = Liquid throw over weir, in.
T = Tray spacing, in.
T_d = Time required to drain tower, hours
u = Velocity, ft./sec.
u_f = Vapor velocity based on area A_f, ft./sec.
u_s = Superficial vapor velocity based on total tower area, ft./sec.
u_w = Velocity of liquid over weir, ft./sec.
V = Total vapor load for tray, cu. ft./sec.
V_c = Vapor load per cap, cu. ft./sec.
V_m = Maximum vapor load for tray, cu. ft./sec.
V_s = Vapor load per slot, cu. ft./sec.
w = Width, in.
w_s = Slot width, in.
w_{sb} = Width of slot at bottom, in.
w_{st} = Width of slot at top, in.
α = Ratio of distance between risers to distance between caps
β = Ratio of distance between caps on parallel liquid pass to that on oblique liquid pass
γ = Ratio of distance between caps to cap diameter
Δ = Liquid gradient for tray or tray section, in.
Δ' = Liquid gradient uncorrected for vapor load, in.
Δ'_r = Liquid gradient per row of caps, uncorrected, in.
Δ'_{ro} = Liquid gradient thru one oblique pass between caps, in.
Δ'_{rp} = Liquid gradient thru one parallel pass between caps, in.
ρ_L = Liquid density, lb./cu. ft.
ρ_V = Vapor density, lb./cu. ft.

the downcomer baffle and enters the bubble-cap section. In order to overcome resistance to flow, a liquid gradient is built up across the tray. The liquid then leaves the bubble-cap section by flowing over the weir and falling into the downcomer on the right. The liquid flowing over the weir carries with it entrained vapor bubbles which must disengage from the liquid to return upwards through the free portion of the downcomer. In flowing over the weir, the liquid is "thrown" beyond the baffle plate, and the "throw over weir" is the distance beyond the baffle plate where the waterfall strikes the material in the downcomer.

The vapor from the tray below, meanwhile, enters the risers of the bubble-caps, reverses on itself, flows down-

ward through the annular space while depressing the liquid level and then passes out through the slots. The slot opening is the distance by which the liquid is depressed below the top of the slots. The vapor forms bubbles at the slots, which rise to the surface of the liquid where they disengage. The distance between the top of the slot and the liquid level is the dynamic slot seal. The vapor pressure drop of the tray is measured between the vapor space above and below the tray. The rising vapor stream carries with it liquid droplets to the tray above, which is called the liquid entrainment.

Because of the liquid gradient across the tray, the hydrostatic liquid head on the downflow side of the tray is less than that at the upstream side. Therefore, more vapor flows through the downstream bubble-caps than through those upstream. This causes variations in vapor distribution across the tray.

Further study of Fig. 1 reveals the reason for the dependability of the bubble-cap tray. The overflow weir may be set at such a height to produce a positive seal of the slots so as to force the vapor to contact the liquid. Furthermore, the maintenance of this liquid seal is not dependent on the flow of vapor; therefore, good vapor-liquid contacting is achieved at low as well as high vapor rates. Furthermore, the contacting of vapor and liquid is not greatly influenced by the flow of liquid, and both low and high liquid rates may be accommodated with good efficiencies.

Slot Opening for Rectangular Slots

The original method for estimating slot opening was derived by Rogers and Thiele,[20] which may be further developed for more convenient use. In the derivation to follow, reference is made to Fig. 2 which illustrates rectangular slots, trapezoidal slots, and triangular slots. For rectangular slots, the derivation begins by application of the orifice equation to a differential element of slot area, wherein the velocity is given by:

$$u = K_s\sqrt{2g\left(\frac{\rho_L-\rho_V}{\rho_V}\right)\left(\frac{h}{12}\right)} \tag{1}$$

The flow of vapor through this differential area is then given by:

$$dV_s = udA = K_s\sqrt{2g\left(\frac{\rho_L-\rho_V}{\rho_V}\right)\left(\frac{h}{12}\right)}\left(\frac{w_s dh}{144}\right) \tag{2}$$

This equation may be integrated to give:

$$V_s = \frac{K_s w_s}{144}\sqrt{\frac{2g}{12}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}\int_0^{h_s} h^{1/2}dh \tag{3}$$

$$V_s = \frac{K_s w_s}{144}\sqrt{\frac{2g}{12}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}\left(\frac{2}{3}\right)h_s^{3/2} \tag{4}$$

By experiment, Rogers and Thiele determined the value of K_s as 0.51, which may be inserted in Equation 4 to give:

$$V_s = 0.00547\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}w_s h_s^{3/2} \tag{5}$$

Applying Equation 5 to the whole tray gives:

$$V = 0.00547 N_s N_c w_s\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}h_s^{3/2} \tag{6}$$

Making a substitution of:

$$A_s = \frac{N_s N_c w_s H_s}{144} \tag{7}$$

in Equation 6 gives:

$$V = 0.79\frac{A_s}{H_s}\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}h_s^{3/2} \tag{8}$$

Solving Equation 8 for slot opening then yields the following convenient design equation for the estimation of slot opening:

$$h_s = 1.17\left(\frac{\rho_V}{\rho_L-\rho_V}\right)^{1/3}(H_s)^{2/3}\left(\frac{V}{A_s}\right)^{2/3} \tag{9}$$

Alternately, the maximum slot capacity may be obtained by substituting H_s for h_s to yield:

$$V_m = 0.79\sqrt{H_s\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}A_s \tag{10}$$

Trapezoidal Slots

For trapezoidal slots, the basic orifice Equation 1 may also be applied to yield the following differential equation for flow of vapor through the differential area:

$$dV_s = udA = K_s\sqrt{2g\left(\frac{\rho_L-\rho_V}{\rho_V}\right)\left(\frac{h}{12}\right)}\frac{wdh}{144} \tag{11}$$

By geometric analysis of the trapezoid, the width of the flow element may be obtained as:

$$w = w_{st}+(w_{sb}-w_{st})\left(\frac{h_s-h}{H_s}\right) \tag{12}$$

Combination of Equations 11 and 12 then yields:

$$dV_s = \frac{K_s}{144}\sqrt{\frac{2g}{12}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}\left[w_{st}+(w_{sb}-w_{st})\left(\frac{h_s-h}{H_s}\right)\right]h^{1/2}dh \tag{13}$$

Rearranging and integrating results in:

$$V_s = \frac{K_s}{144}\sqrt{\frac{2g}{12}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}\left[\int_0^{h_s} w_{st}h^{1/2}dh + \int_0^{h_s}(w_{sb}-w_{st})\left(\frac{h_s}{H_s}\right)h^{1/2}dh - \int_0^{h_s}\left(\frac{w_{sb}-w_{st}}{H_s}\right)h^{3/2}dh\right] \tag{14}$$

$$V_s = \frac{K_s}{144}\sqrt{\frac{2g}{12}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}\left[\frac{2}{3}w_{st}h_s^{3/2} + \frac{2}{3}\left(\frac{w_{sb}-w_{st}}{H_s}\right)h_s^{5/2} - \frac{2}{5}\left(\frac{w_{sb}-w_{st}}{H_s}\right)h_s^{5/2}\right] \tag{15}$$

Introducing $K_s = 0.51$ in Equation 15 gives:

$$V_s = 0.00820\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}\left[\frac{2}{3}w_{st}h_s^{3/2}+\frac{4}{15}\left(\frac{w_{sb}-w_{st}}{H_s}\right)h_s^{5/2}\right] \quad (16)$$

Application of Equation 16 to the whole tray results in:

$$V = 0.00820N_sN_c\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}\left[\frac{2}{3}w_{st}h_s^{3/2}+\frac{4}{15}\left(\frac{w_{sb}-w_{st}}{H_s}\right)h_s^{5/2}\right] \quad (17)$$

But the total tray slot area may be expressed as:

$$A_s = N_sN_cH_s\left(\frac{w_{sb}+w_{st}}{2\times144}\right) \quad (18)$$

Combining Equations 17 and 18 results in:

$$V = 2.36\frac{A_s}{H_s}\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}\left[\frac{2}{3}\left(\frac{w_{st}}{w_{sb}+w_{st}}\right)h_s^{3/2}+\frac{4}{15}\left(\frac{w_{sb}-w_{st}}{w_{sb}+w_{st}}\right)\frac{h_s^{5/2}}{H_s}\right] \quad (19)$$

Equation 19 may be simplified by introducing:

$$R_s = \frac{w_{st}}{w_{sb}} \quad (20)$$

which may be modified to give:

$$\frac{w_{st}}{w_{sb}+w_{st}} = \frac{R_s}{1+R_s} \quad (21)$$

$$\frac{w_{sb}-w_{st}}{w_{sb}+w_{st}} = \frac{1-R_s}{1+R_s} \quad (22)$$

Introducing Equations 21 and 22 in Equation 19 finally results in:

$$V = 2.36\frac{A_s}{H_s}\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}\left[\frac{2}{3}\left(\frac{R_s}{1+R_s}\right)h_s^{3/2}+\frac{4}{15}\left(\frac{1-R_s}{1+R_s}\right)\frac{h_s^{5/2}}{H_s}\right] \quad (23)$$

Equation 23 represents the simplest possible equation for the opening of trapezoidal slots, but it will be apparent that trial-and-error must be employed. However, it is possible to develop a direct solution by graphical means. First, the maximum slot capacity is obtained by substitution of H_s for h_s, which results in:

$$V_m = 2.36\left[\frac{2}{3}\left(\frac{R_s}{1+R_s}\right)+\frac{4}{15}\left(\frac{1-R_s}{1+R_s}\right)\right]\sqrt{H_s\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}A_s \quad (24)$$

Equations 23 and 24 are then combined to develop Fig. 3, which gives the slot opening for any shape trapezoidal slot. First the maximum slot capacity is calculated by means of the equation on the chart. Then the slot opening is obtained from the graph as a function of the actual vapor load, following the curve for the proper trapezoid shape factor, R_s. For shape factors other than those plotted interpolation may be employed. It will be noted that in the limiting case where $R_s = 0$ the trapezoid reduces to a triangle, and in the other extreme where $R_s = 1.00$ the shape becomes a rectangle.

Triangular Slots

Equations for triangular slots are easily obtained by substitution of $R_s = 0$ in the equations for trapezoidal slots. Making this substitution in Equation 23 results in:

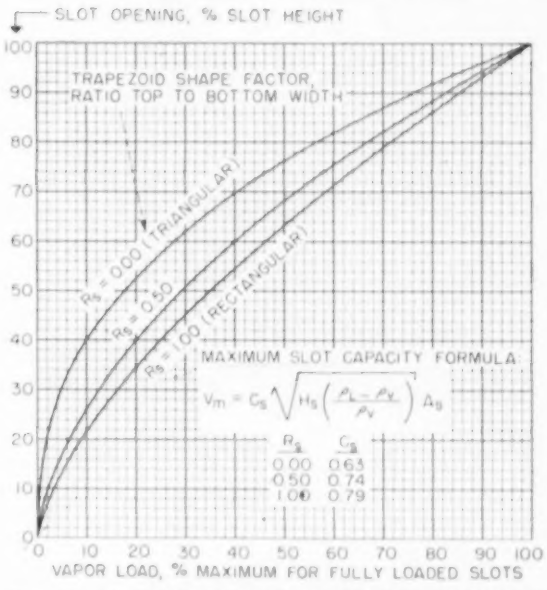

SLOT OPENING, % SLOT HEIGHT
TRAPEZOID SHAPE FACTOR, RATIO TOP TO BOTTOM WIDTH
Rs = 0.00 (TRIANGULAR)
Rs = 0.50
Rs = 1.00 (RECTANGULAR)
MAXIMUM SLOT CAPACITY FORMULA
$V_m = C_s\sqrt{H_s\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}A_s$
Rs Cs
0.00 0.63
0.50 0.74
1.00 0.79
0 10 20 30 40 50 60 70 80 90 100
VAPOR LOAD, % MAXIMUM FOR FULLY LOADED SLOTS

Fig. 3—**TRAPEZOIDAL SLOT GENERALIZED CORRELATION**

$$V = 0.63\frac{A_s}{H_s^{1/2}}\sqrt{\frac{\rho_L-\rho_V}{\rho_V}}h_s^{3/2} \quad (25)$$

Solving Equation 25 for h_s results in the following design equation for slot opening in triangular slots:

$$h_s = 1.20\left(\frac{\rho_V}{\rho_L-\rho_V}\right)^{1/3}(H_s)^{1/3}\left(\frac{V}{A_s}\right)^{2/3} \quad (26)$$

For maximum slot capacity, Equation 26 reduces to:

$$V_m = 0.63\sqrt{H\left(\frac{\rho_L-\rho_V}{\rho_V}\right)}A_s \quad (27)$$

Liquid Height Over Weir

The height of liquid over straight weirs is given by the Francis weir formula:

$$h_{ow} = 0.092\left(\frac{Q}{L_w}\right)^{2/3} \quad (28)$$

When the weir is located so as to discharge into a segmental downcomer, the tower wall has a constricting effect on the flow of liquid over the weir, and a correction factor, F_w, must be introduced:

$$h_{ow} = 0.092F_w\left(\frac{Q}{L_w}\right)^{2/3} \quad (29)$$

In a previous article,[1] an equation was derived for the weir constriction correction factor, as follows:

$$\frac{Q}{(L_w)^{2.5}} = 485\left[\frac{\sqrt{1-(K_w)^3}-(F_w)^3\sqrt{1-(K_w)^3}}{(K_w)(F_w)}\right]^{2/3} \quad (30)$$

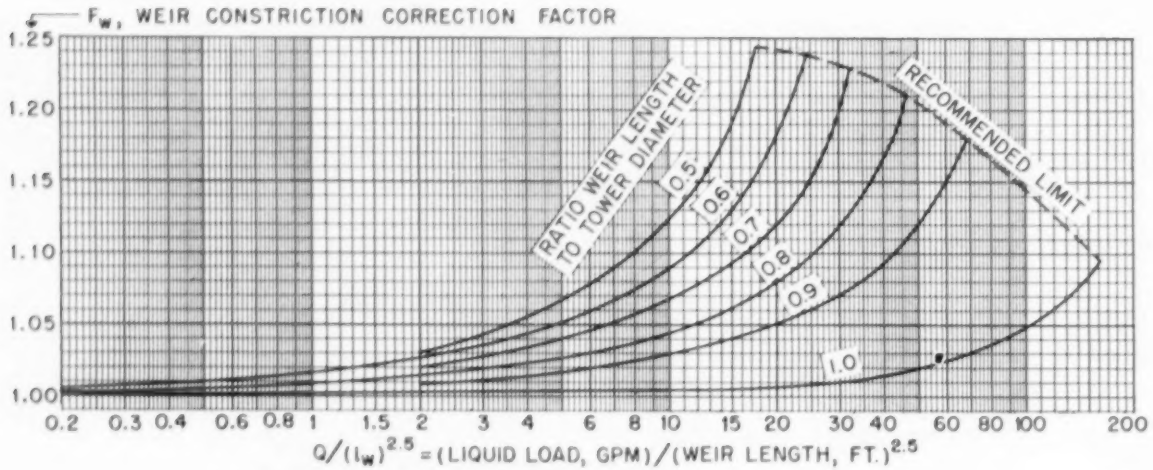


Fig. 4—**WEIR FORMULA CORRECTION FACTOR** for constricting tower wall

This equation cannot be solved directly for F_w, and so a convenient working chart is presented in Fig. 4.

The height of liquid over notched weirs, with notches running full, is given by:[10]

$$Q = 14.3\frac{l_w}{h_n}\left[h_{ow}^{5/2} - (h_{ow} - h_n)^{5/2}\right] \quad (31)$$

However, if the notches are running less than full, an alternate formula must be employed:

$$Q = 13.3\frac{l_w}{h_n}(h_{ow})^{5/2} \quad (32)$$

Liquid Throw Over Weir

The following derivation for the liquid throw formula is best understood by reference to Fig. 5. Here, the velocity of liquid over the weir in a horizontal direction is given by:

$$u_w = \left(\frac{Q}{60\times 7.48}\right)\left(\frac{12}{l_w h_{ow}}\right) = 0.0268\left(\frac{Q}{l_w}\right)\left(\frac{1}{h_{ow}}\right) \quad (33)$$

But from the straight weir formula, we may obtain:

$$\frac{Q}{l_w} = 35.7(h_{ow})^{3/2} \quad (34)$$

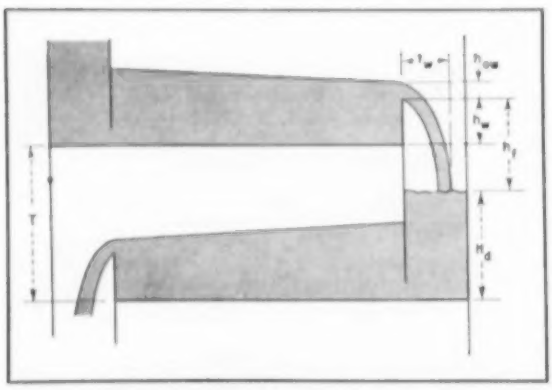


Fig. 5—**LIQUID THROW FORMULA** derivation diagram

Combining Equations 33 and 34 then gives:

$$u_w = 0.96\sqrt{h_{ow}} \quad (35)$$

An application of the Newtonian law of gravity gives:

$$\frac{h_f}{12} = \int g t dt = \frac{1}{2}gt^2 \quad (36)$$

from which the time of free fall may be obtained:

$$t = \sqrt{\frac{2h_f}{12g}} \quad (37)$$

Finally, the liquid throw over the weir can be obtained by a combination of Equations 35 and 37:

$$t_w = 12u_w t = 12\left(0.96\sqrt{h_{ow}}\right)\sqrt{\frac{2h_f}{12g}} \quad (38)$$

which may be simplified as follows:

$$t_w = 0.8\sqrt{h_{ow}h_f} \quad (39)$$

The distance of free fall to be used in Equation 39 is given by:

$$h_f = T + h_w - H_d \quad (40)$$

It will be noted that the above derivation applies only to straight weirs, and that the weir constriction correction factor is neglected.

Liquid Gradient

The only published general method for the calculation of liquid gradient is that developed by Davies.[7] According to this method, which is based on a fundamental analysis of fluid hydraulics supplemented with experimental data, the liquid gradient (uncorrected for vapor load) is given by the following equation:

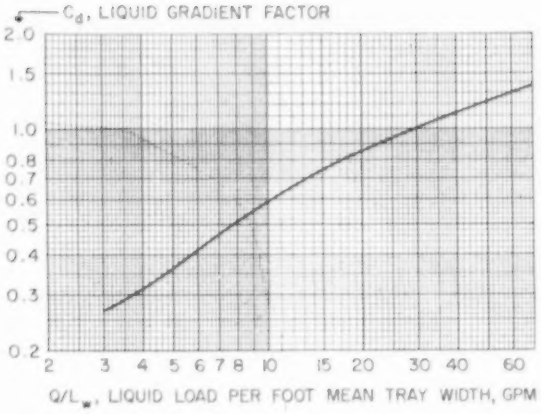


Fig. 6—**LIQUID GRADIENT FACTOR CHART** for no-hold down bars

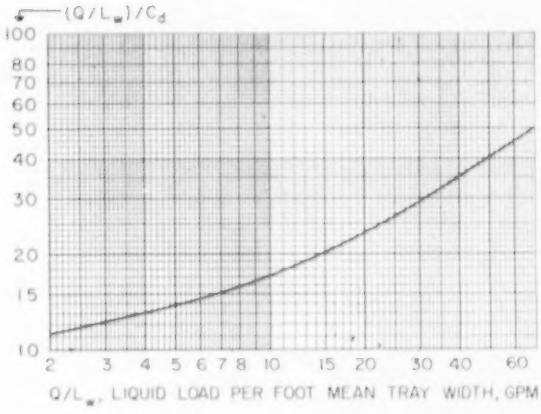


Fig. 7—**MODIFIED LIQUID GRADIENT FACTOR CHART** for no hold-down bars

$$\sum \Delta' \left\{ \Delta' \left[3\left(\frac{N_r}{2}-1\right) + \frac{2}{1+\frac{1}{4}\beta^2} \right] + 3N_r \left[h_{lc} + s(\alpha-1) \right] \right\} = \frac{N_r \sum N_r \sqrt{1+\frac{1}{4}\beta^2}\, Q}{2.4 C_d L_c} \quad (41)$$

For bubble-caps placed on equilateral triangular pitch, $\beta = 1$, and the above equation reduces to:

$$\sum \Delta' \left\{ \Delta' \left(\frac{3N_r}{2} - 1.4 \right) + 3N_r \left[h_{lc} + s(\alpha-1) \right] \right\} = \frac{N_r \sum N_r \, Q}{2.15 C_d L_c} \quad (42)$$

It should be apparent that these equations are very cumbersome, and that trial-and-error is necessary for the solution of liquid gradient.

A study of the original derivation revealed that some algebraic manipulations might result in a considerably more convenient method. According to Davies, the liquid gradient due to flow through the parallel passes between caps in one row is given by:

$$Q = 2.4 C_d \sum \Delta'_{rp} \left\{ 3 \left[L_c (h_l - s) + L_{cs} \right] + 2L \Delta'_{rp} \right\} \quad (43)$$

and the liquid gradient due to flow through the oblique passes between caps in one row is given by:

$$\Delta'_{ro} = \Delta'_{rp} \frac{\beta^2}{4} \quad (44)$$

For equilateral triangular pitch, $\beta = 1$, and Equation 44 reduces to:

$$\Delta'_{ro} = \frac{1}{4} \Delta'_{rp} \quad (45)$$

and the total liquid gradient per row for equilateral triangular pitch becomes:

$$\Delta'_r = \Delta'_{rp} + \Delta'_{ro} = \frac{5}{4} \Delta'_{rp} \quad (46)$$

Combining Equations 43 and 46 then results in:

$$Q = 2.15 C_d \sum \Delta'_r \left\{ 3 \left[L_c (h_l - s) + L_{cs} \right] + 1.6 L \Delta'_r \right\} \quad (47)$$

Substituting $L = aL_c$, this reduces to:

$$Q = 2.15 C_d \sum \Delta'_r \left\{ 3L \left[h_l + s(\alpha-1) \right] + 1.6 L \Delta'_r \right\} \quad (48)$$

and substituting:

$$L_c = \left(\frac{\gamma}{1+\gamma} \right) \frac{L_{cs}}{12} \quad (49)$$

we obtain:

$$Q = 2.15 C_d \sum \Delta'_r \left\{ 3 \left(\frac{\gamma}{1+\gamma} \right) \left(\frac{L_{cs}}{12} \right) \left[h_l + s(\alpha-1) \right] + 1.6 \left(\frac{\gamma}{1+\gamma} \right) \left(\frac{L_{cs}}{12} \right) \Delta'_r \right\} \quad (50)$$

For optimum cap design, the riser diameter is approximately 0.7 times the cap diameter, which results in:

$$\alpha = \frac{\gamma + 1 - 0.7}{\gamma} = \frac{\gamma + 0.3}{\gamma} \quad (51)$$

Combining Equations 50 and 51 gives:

$$Q = 2.15 C_d \sum \Delta'_r \left\{ 3 \left(\frac{\gamma}{1+\gamma} \right) \left(\frac{L_{cs}}{12} \right) \left[h_l + s \left(\frac{0.3}{\gamma} \right) \right] + 1.6 \left(\frac{\gamma}{1+\gamma} \right) \left(\frac{L_{cs}}{12} \right) \Delta'_r \right\} \quad (52)$$

and after rearranging, we obtain:

$$\frac{Q L_{cs}}{C_d} = 25.8 \left(\frac{\gamma}{1+\gamma} \right) \sum \Delta'_r \left[1.6 \Delta'_r + 3 \left(h_l + \frac{0.3 s}{\gamma} \right) \right] \quad (53)$$

Equation 53 gives us a working formula which can now be used to develop design charts for liquid gradient.

Working charts shown on next four pages

Text continues on page 76

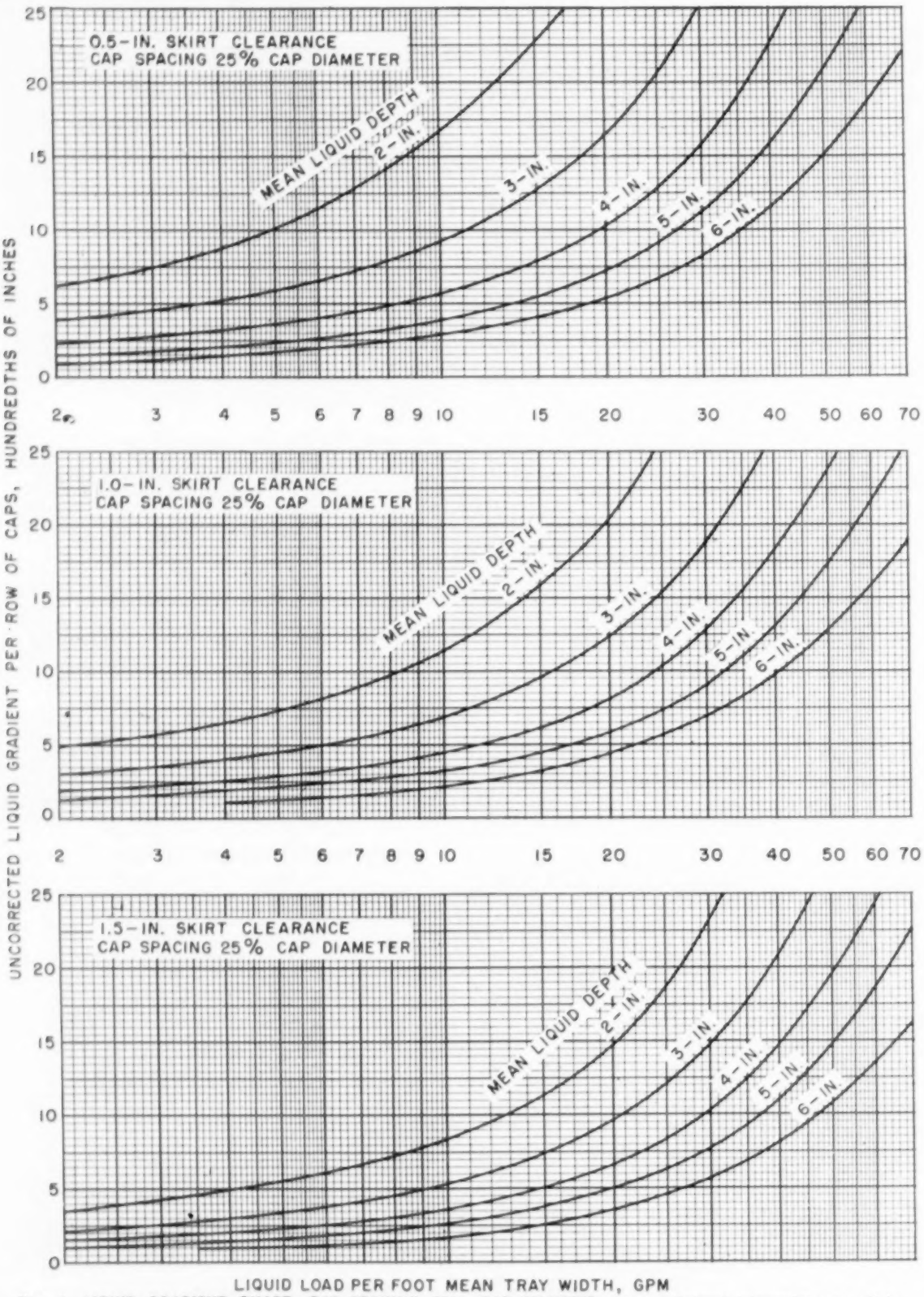

0.5-IN. SKIRT CLEARANCE
CAP SPACING 25% CAP DIAMETER
MEAN LIQUID DEPTH
2-IN.
3-IN.
4-IN.
5-IN.
6-IN.
1.0-IN. SKIRT CLEARANCE
CAP SPACING 25% CAP DIAMETER
1.5-IN. SKIRT CLEARANCE
CAP SPACING 25% CAP DIAMETER
UNCORRECTED LIQUID GRADIENT PER ROW OF CAPS, HUNDREDTHS OF INCHES
0 5 10 15 20 25
2 3 4 5 6 7 8 9 10 15 20 30 40 50 60 70
LIQUID LOAD PER FOOT MEAN TRAY WIDTH, GPM

Fig. 8—**LIQUID GRADIENT CHART—CAP SPACING 25% CAP DIAMETER**—for equilateral triangular cap pitch. Mean Liquid Depth = $h_w + h_{ow} + \frac{1}{2}\Delta$

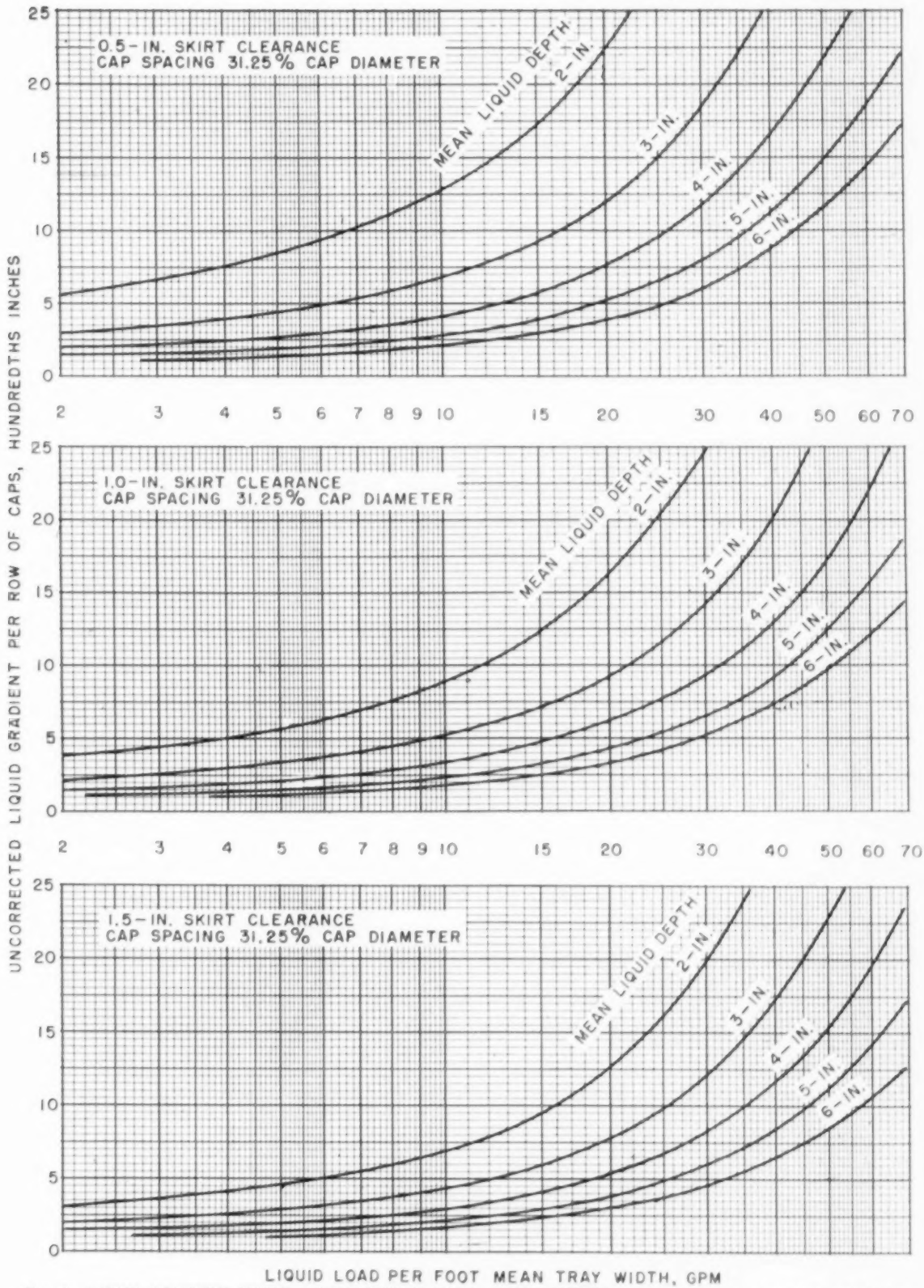


Fig. 9—**LIQUID GRADIENT CHART—CAP SPACING 31.25% CAP DIAMETER**—for equilateral triangular cap pitch. Mean Liquid Depth = $h_w + h_{ow} + \frac{1}{2}\Delta$

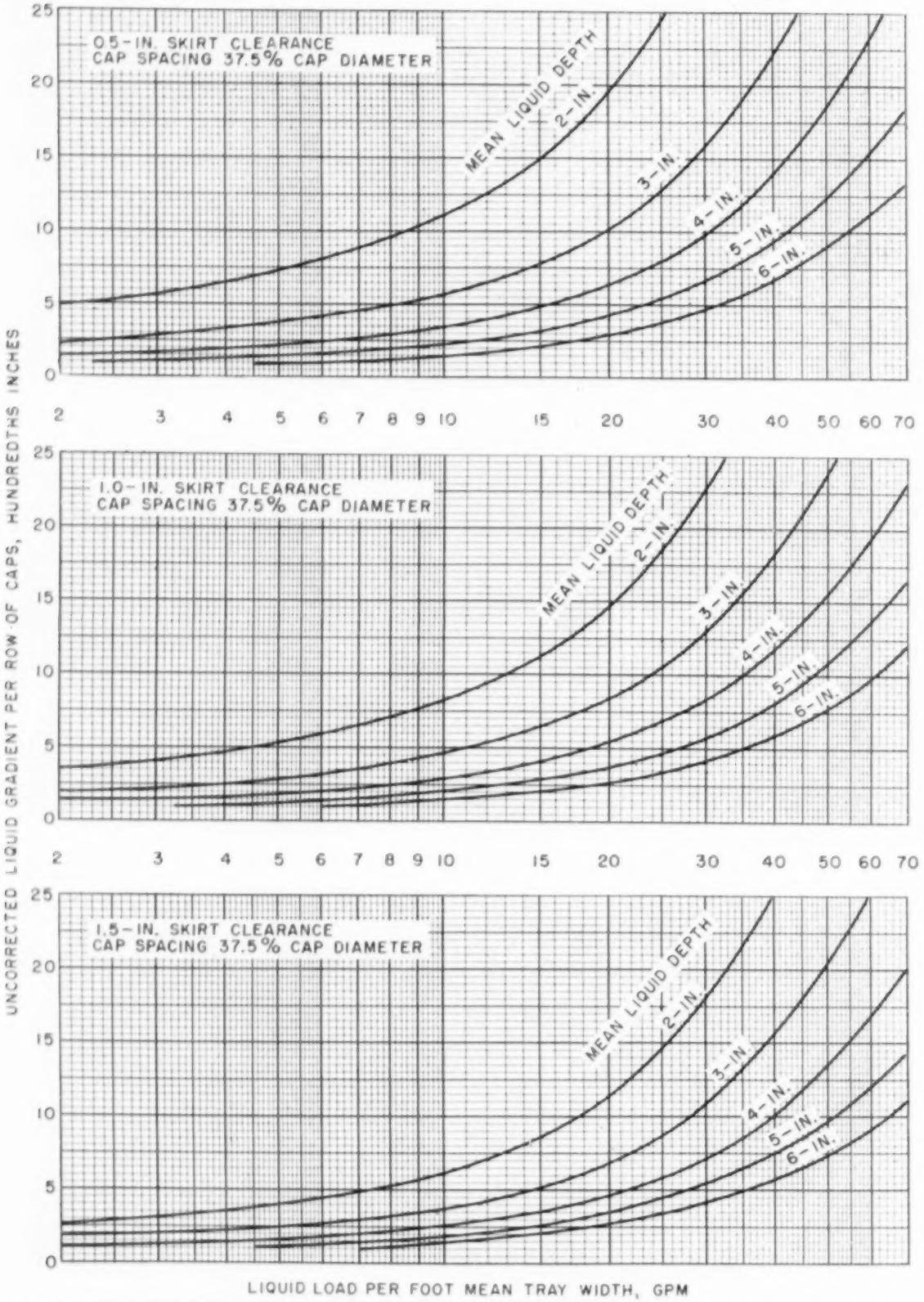


Fig. 10—**LIQUID GRADIENT CHART—CAP SPACING—37.5% CAP DIAMETER**—for equilateral triangular cap pitch. Mean Liquid Depth = $h_w + h_{ow} + \frac{1}{2}\Delta$

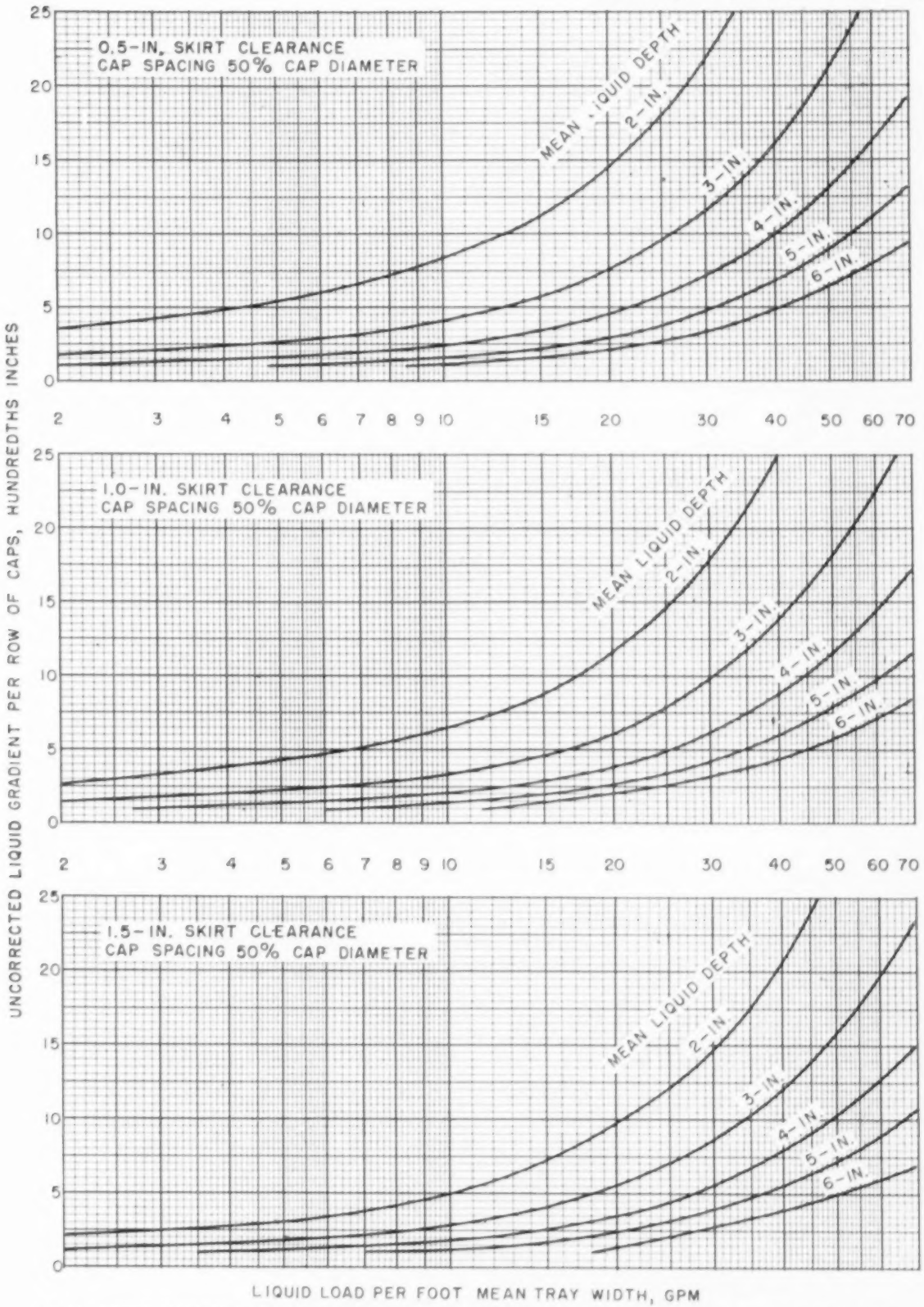


Fig. 11—**LIQUID GRADIENT CHART—CAP SPACING—50% CAP DIAMETER**—for equilateral triangular cap pitch.
Mean Liquid Depth = $h_w + h_{ow} + \frac{1}{2}\Delta$

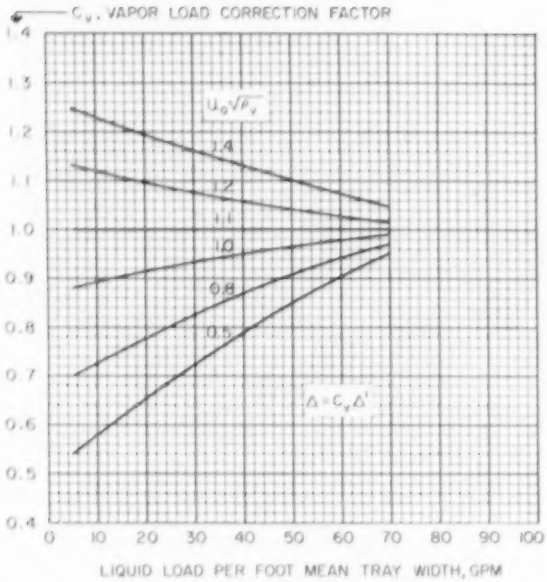


Fig. 12—**CORRECTION OF LIQUID GRADIENT** for vapor load

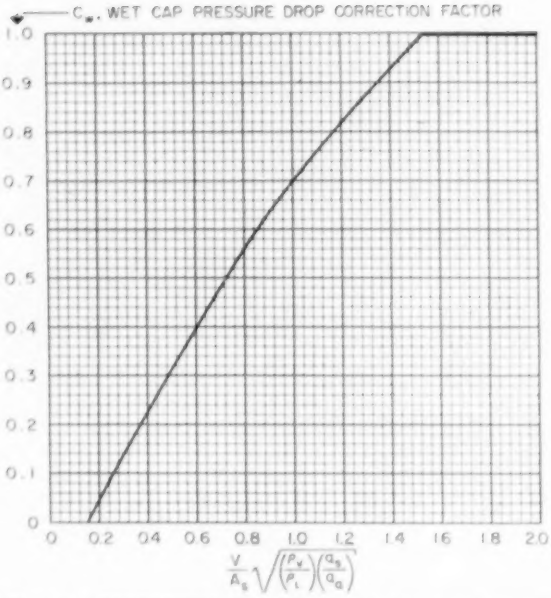


Fig. 13—**CORRECTION FOR WET CAP PRESSURE DROP**

Liquid Gradient Charts

In order to solve Equation 53 it is necessary to introduce the liquid gradient factor, C_4. Davies'[12] plot of this factor is given in Fig. 6. This correlation is then modified as shown in Fig. 7 to give the working chart which is used in conjunction with Equation 53.

For example, for any combination of values of the ratio of cap spacing to cap diameter, skirt clearance, mean liquid depth and liquid gradient Equation 53 can be solved for $(Q/L_w)/C_4$. With this value it is then possible to determine from Fig. 7 the liquid load per foot mean tray width corresponding to these conditions.

In this manner a set of working charts were developed, and are presented in Figs. 8, 9, 10, and 11. These charts, which permit rapid graphical determination of liquid gradient (uncorrected), cover the entire practical range of tray design variables for equilateral triangular cap pitch. The liquid gradient obtained from these charts, however, must be corrected for vapor load. This is accomplished through the utilization of Fig. 12, obtained from Davies.[9]

It will be noted that in the development of the liquid gradient design charts, the only simplifying assumption made was that the riser diameter is 0.7 times the cap diameter. In order to illustrate the accuracy of the new simplified liquid gradient charts, an example tray design problem was chosen for which the new graphical method was compared with the original Davies method. The tray design and operating conditions for this comparison are given in Table 2. In this example the new method gave a liquid gradient of 1.56 inches, whereas the original Davies method gave 1.58 inches.

Vapor Pressure Drop

The most widely used method for the computation of vapor pressure drop is that of Dauphine.[13] According to this method, the pressure drop due to vapor flow through the risers is given by:

$$h_v = 0.111\frac{d_r}{\rho_L}\left[\sqrt{\rho_v}\left(\frac{V}{A_r}\right)\right]^{1.99} \quad (54)$$

The pressure drop through the reversal and annulus (assuming reversal area is greater than annular area) is given by:

$$h_{va} = \frac{0.68}{\rho_L}\left[\left(\frac{2a_r^2}{a_a d_r}\right)\sqrt{\rho_v}\left(\frac{V}{A_r}\right)\right]^{1.71} \quad (55)$$

And the pressure drop through the dry slots is given by:

$$h_v' = \frac{0.163}{\rho_L}\left[\sqrt{d_r\rho_v}\left(\frac{V}{A_r}\right)\right]^{1.72} \quad (56)$$

Table 2—Comparison of results of liquid gradient methods

Tray Design	
Tower diameter	15 ft.
Tray spacing	24 in.
Tray type	cross-flow
Weir length	10.5 ft.
Weir height	3.25 in.
Bubble Cap OD	6.0 in.
Riser OD	4.1 in.
Cap pitch	equilateral triangular
Cap spacing	2.25 in.
Skirt clearance	0.50 in.
No. of caps per tray	325
No. of rows normal flow	17
Operating Conditions	
Material	benzene
Pressure	14.70 psia
Temperature	176°F.
Vapor density	0.1680 lb./cu.ft.
Vapor load	240,000 lb./hr. or 397 cu.ft./sec.
Liquid load	200,000 lb./hr. or 577 gpm
Calculated Liquid Gradients	
Davies method	1.58 in.
New method	1.56 in.

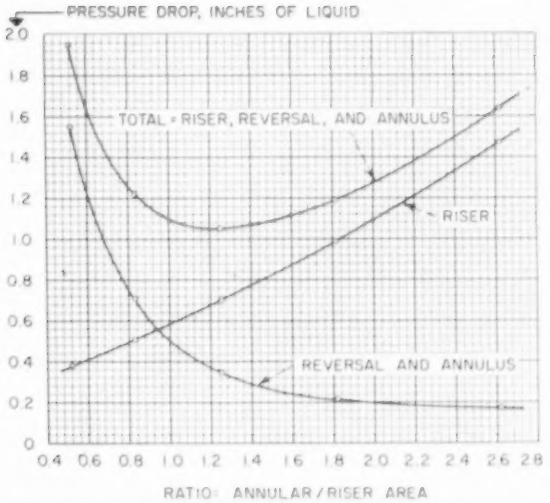


Fig. 14—**EFFECT OF ANNULAR/RISER AREA RATIO ON PRESSURE DROP**, calculated by Dauphine Equations. System is benzene at atmospheric pressure with standard 4-inch bubble-caps loaded to 100% slot capacity

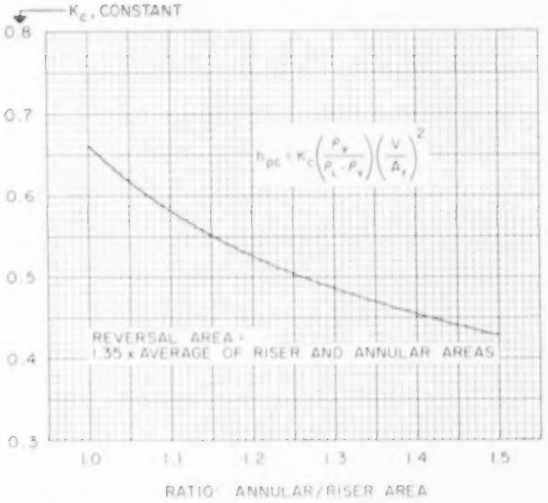


Fig. 15—**BUBBLE-CAP PRESSURE DROP CONSTANT**

The total dry cap pressure drop is then obtained by summing up the three individual drops as follows:

$$h_c' = h_r + h_{ra} + h_s' \qquad (57)$$

Finally, the wet cap pressure drop may be obtained by:

$$h_c = \frac{h_c'}{C_w} \qquad (58)$$

where the wet cap pressure drop correction factor is given by the correlation presented in Fig. 13.

It should be apparent that repeated solution of these equations for pressure drop would be somewhat laborious. As the first step in the development of a simplified method for the calculation of pressure drop, the Dauphine equations were utilized to study the effect of annular/riser area ratio. For this purpose a conventional four-inch bubble-cap was chosen in which the riser diameter was varied while the cap was loaded with vapor from an example design case, as shown in Table 3. The Dauphine equations were then employed to compute the pressure drop as the annular/riser area ratio was varied. The results of these calculations are shown in Fig. 14. Here it is clearly shown that as the annular area increases the riser pressure drop increases, whereas the pressure drop through the reversal and annulus decreases. This produces a minimum in the total pressure drop curve.

The orifice equation was then adapted to a bubble-cap as follows:

$$h_{pc} = K_c\left(\frac{\rho_v}{\rho_L - \rho_v}\right)\left(\frac{V}{A_r}\right)^2 \qquad (59)$$

Since the principal variable of cap design is annular/riser area ratio, let:

$$K_c = f\left(\frac{A_a}{A_r}\right) \qquad (60)$$

The calculated results shown in Fig. 14 were then utilized to determine the function expressed in Equation 60. These results are presented in Fig. 15. It is then proposed that the partial cap pressure drop be calculated from Equation 59, using values of the constant from Fig. 15.

Since the slot pressure drop is equal to the slot opening, the total bubble-cap pressure drop may be obtained by:

$$h_c = h_{pc} + h_s \qquad (61)$$

where h_s is obtained by Equation 9, 23, or 26. Finally, reference to Fig. 1 will show that the total tray pressure drop may be developed as:

$$h_t = h_c + h_{ca} + h_{ow} + \frac{1}{2}\Delta \qquad (62)$$

Table 3—Basis for determination of effect of annular/riser area ratio on pressure drop

Basic Cap Design	
Nominal size	4 in.
Cap:	
Thickness	12 gage U.S. Std.
Outside diameter	4.093 in.
Inside diameter	3.875 in.
Height overall	3.000 in.
No. of slots	26
Type of slots	trapezoidal
Slot width	0.333 x 0.167 in.
Slot height	1.25 in.
Height shroud ring	0.25 in.
Riser:	
Thickness	12 gage U.S. Std.
Outside diameter	variable
Inside diameter	variable
Bolt diameter	0.375 in.
Riser—slot seal	0.500 in.
Operating Conditions	
Material	benzene
Pressure	14.70 psia
Temperature	176°F.
Liquid density	43.3 lb./cu.ft.
Vapor density	0.1680 lb./cu.ft.
Vapor load per cap	0.77 cu.ft./sec.
Slot opening	1.25 in.

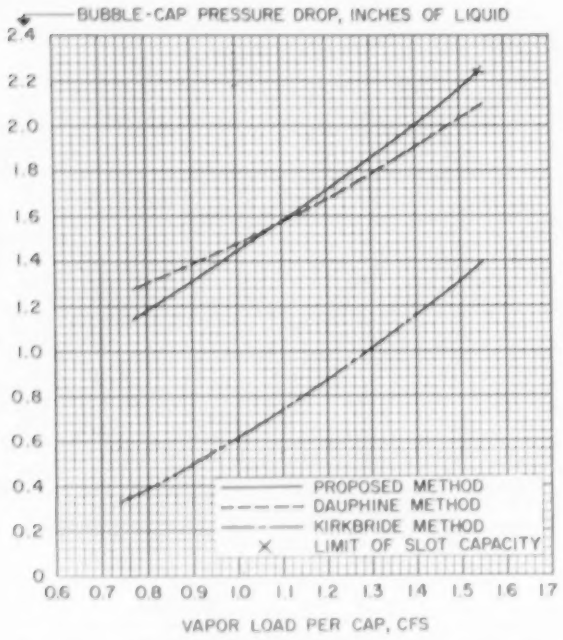


Fig. 16—**COMPARISON OF PROPOSED METHOD FOR PRESSURE DROP** with Dauphine and Kirkbride methods in benzene system at atmospheric pressure using standard 6-inch bubble-caps

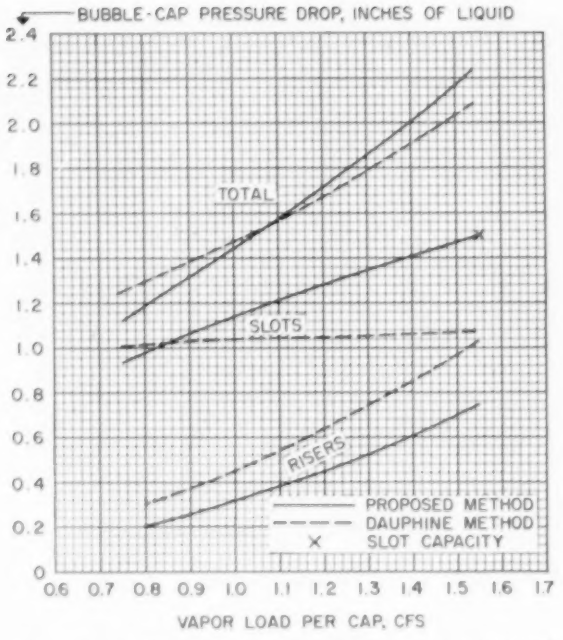


Fig. 17—**COMPARISON OF PROPOSED AND DAUPHINE METHODS** for bubble-cap pressure drop in benzene system at atmospheric pressure using standard 6-inch bubble-caps

In order to illustrate the accuracy of the simplified method for bubble-cap pressure drop, the new method was compared with the original Dauphine equations, as well as the Kirkbride method,[19] for varying loads in a conventional six-inch bubble-cap. For this purpose the bubble-cap was subjected to varying loads of benzene vapor at atmospheric pressure, with the results presented in Fig. 16.

In order to further compare the proposed and Dauphine methods, the bubble-cap pressure drop was broken down into that through the risers (and reversal and annulus) and that through the slots. These results, which are shown in Fig. 17, demonstrate that the Dauphine method indicates essentially no variation in slot drop as the load varies. This of course is not true, and illustrates a weakness of the Dauphine wet cap correction factor correlation.

The slight difference between the riser pressure drops is attributed to the fact that the cap pressure drop constant was determined for a four-inch cap, whereas a six-inch cap was used in the accuracy comparison.

Liquid Height in Downcomer

The liquid head loss under the downflow baffle is given by:

$$h_d = 0.03\left(\frac{Q}{100A_d}\right)^2 \qquad (63)$$

Analysis of the liquid hydraulics in Fig. 1 will then show that the depth of clear liquid in the downcomer may be obtained by:

$$H_d = h_w + h_{ow} + \Delta + h_d + h_f \qquad (64)$$

As yet, there has been developed no satisfactory method for predicting the depth of foam in the downcomers.

Entrainment

Entrainment is defined as the liquid carried with the vapor from one tray to the tray above. Entrainment is detrimental for two reasons. First, it lowers plate efficiency since it carries liquid from a tray of lower volatility to a tray containing liquid of higher volatility thereby diluting the effect of fractionation. Second, entrainment may also be detrimental since it carries nonvolatile constituents upwards with the result that nonvolatile impurities in the feed may be carried up the column to contaminate the distillate.

In spite of the importance of entrainment as a factor to reckon with in fractionation, the publication of useful experimental data has been very disappointing. One of the first publications of experimental entrainment data was that of Holbrook and Baker in 1934.[21] These investigators studied entrainment in an eight-inch column with trays fitted with round bubble-caps. The system investigated was steam and water (containing salt). The variables studied included plate spacing, slot width, slot area, and vapor load.

Sherwood and Jenny[22] in 1935 presented data on entrainment in a larger column, 18 inches in diameter, fitted with round bubble-caps. The variables studied included plate spacing (9-30 in.), cap arrangement, liquid level (1-2 in.), and vapor load. The results showed that entrainment is increased by superficial vapor velocity, increased by slot velocity, decreased by plate spacing, and increased by liquid level.

After a considerable lapse of time during which there was very little published on entrainment, Atteridg,

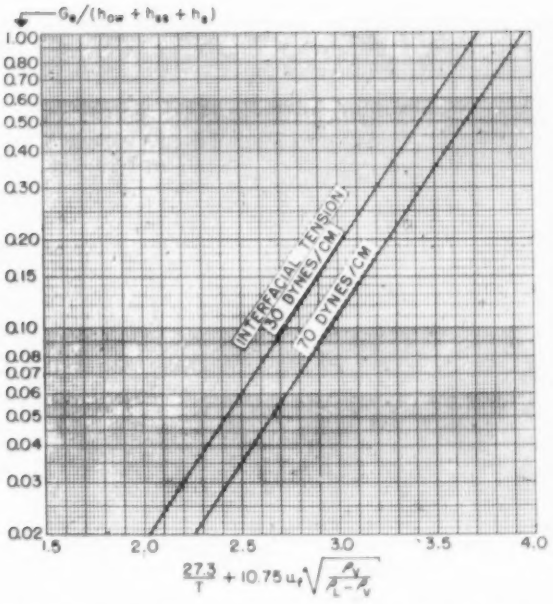


Fig. 18—**CORRELATION OF ENTRAINMENT,** Simkin, Strand and Olney

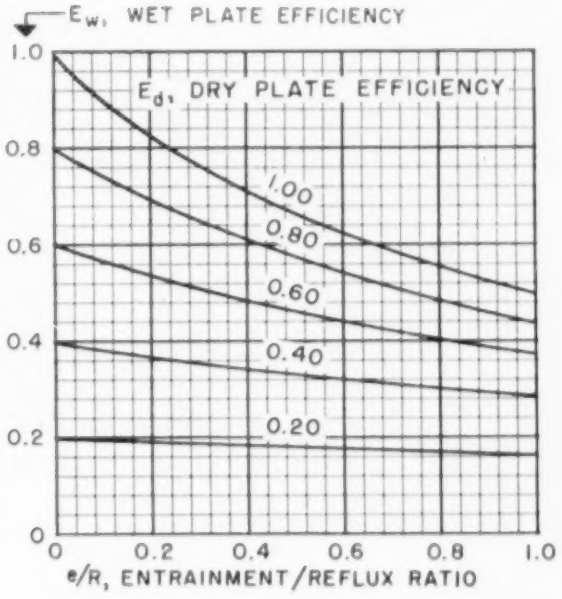


Fig. 19—**EFFECT OF ENTRAINMENT ON PLATE EFFICIENCY**

Lemieux, Schreine, and Sundback[11] in 1953 presented the results of experiments on entrainment in a seven-foot diameter tower fitted with rectangular caps. Here, again, the system was air and water. The variables studied included tray variations and vapor load.

Then Simkin, Strand, and Olney[12b] in 1954 published entrainment results obtained in a 15-inch diameter column fitted with two round bubble-caps per tray. Two systems were studied: air-water, and air-spindle oil. The principal variables studied included tray spacing, weir height, and vapor load. These investigators compared the results of their experiments with those of previous workers, and developed a correlation for which they claim good agreement with all data studied. This correlation is presented in Fig. 18. While this correlation was proposed as a generalized one, it should be realized that it is based on very limited data on a few isolated systems under narrow ranges of operating conditions. Furthermore, this correlation is essentially empirical and has little theoretical foundation. This should be apparent by the inconsistency in the dimensional analysis exhibited in the correlation.

Nevertheless, this correlation remains the only published generalized correlation for entrainment. It is hoped that more work will be directed toward the development of a theoretically-sound and reliably-proven generalized correlation for entrainment.

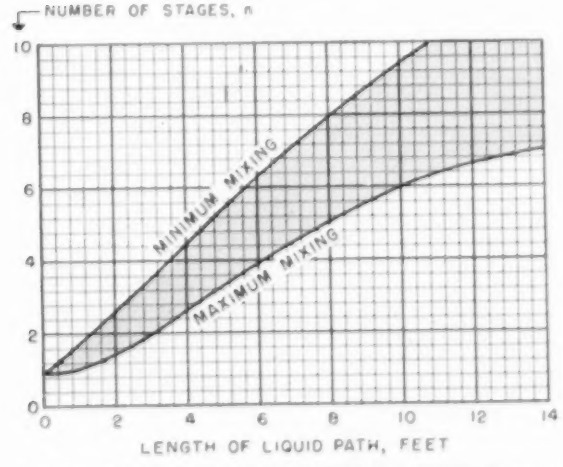


Fig. 20—**CORRELATION FOR NUMBER OF LIQUID STAGES** with length of liquid path and degree of mixing

Plate Efficiency

Plate efficiency is defined as the number of theoretical plates required for a given separation, divided by the number of actual plates provided. Since plate efficiency is dependent on the nature of vapor-liquid contacting on the tray, it should be apparent that plate efficiency is influenced by the tray, and should therefore be considered in tray design. Unfortunately the prediction of plate efficiency is still more art than science and no really reliable correlations are presently available. However, it seems appropriate that a few general principles should be mentioned here.

An evaluation of plate efficiency can be divided into three parts:

1—Local dry vapor (Murphree) efficiency.
2—Effect of entrainment on efficiency.
3—Effect of liquid concentration gradient on efficiency.

The only theoretically sound published method of estimating local dry vapor efficiencies is that of Geddes.[13b] This method is based on a highly idealized picture of bubble-tray action, and includes a number of assumptions which had to be made in the absence of actual data. However, the Geddes method still remains as the only one which gives a basis for estimating the effect of

tray design on plate efficiency. A review of the Geddes article will not be given here. It should suffice to point out that the method indicates that high efficiencies are favored by small slots, small slot openings, and high slot submergences.

The effect of entrainment on plate efficiency was originally derived by Colburn.[7] His derivation, which is on a theoretically sound basis, results in the following equation for the effect of entrainment on plate efficiency:

$$E_{ea} = \frac{E_d}{1+\frac{eE_d}{R}} \qquad (65)$$

This equation is shown in graphical form in Fig. 19. Here it will be apparent that entrainment has the most pronounced effect on efficiency with high dry plate efficiencies. Also, this correlation illustrates the importance of having a reliable method for estimating the amount of entrainment.

If the liquid on the entire tray were in a state of complete mixing, the liquid concentration at all points on the tray would be the same. However, the flow of liquid across the tray actually results in a concentration gradient. Furthermore, this concentration gradient acts in such a way as to improve plate efficiency. This situation has been analyzed by Gautreaux and O'Connell,[11] who have derived the following equation for the effect of liquid concentration gradient on plate efficiency:

$$E_a = R\left[\left(1+\frac{E_{ea}}{nR}\right)^n - 1\right] \qquad (66)$$

From an evaluation of experimental data, these investigators have developed a correlation for the number of liquid stages for use in Equation 66. This correlation is presented in Fig. 20.

Summary of Working Methods

Slot Opening: For rectangular slots use Equation 9, for trapezoidal slots use Equation 23, and for triangular slots use Equation 26, or, Fig. 3 may be used for all types of slots.

Maximum Slot Capacity: For rectangular slots use Equation 10, for trapezoidal slots use Equation 24, and for triangular slots use Equation 27.

Liquid Height Over Weir: For straight weirs use Equation 29, in which the correction factor is obtained from Fig. 4. For notched weirs running full use Equation 31, and where notches are less than full use Equation 32.

Liquid Throw Over Weir: Use Equation 40 to determine the distance of free fall, and apply in Equation 39 for liquid throw.

Liquid Gradient: For caps on equilateral triangular pitch, determine uncorrected gradient per row of caps from Fig. 8,9,10, or 11, depending on cap spacing (interpolating for intermediate cap spacings). Multiply uncorrected gradient by number of rows. Correct for vapor load by means of Fig. 12. For other cap pitches use Equation 41.

Vapor Pressure Drop: For the partial cap drop through risers, reversals, and annuli use Equation 59 in which the coefficient is obtained from Fig. 15. Calculate the total cap drop by Equation 61. Calculate the total tray pressure drop by Equation 62.

Liquid Height in Downcomer: Calculate the head loss under downflow baffle by Equation 63. Calculate the depth of clear liquid in the downcomer by Equation 64.

Entrainment: Use Fig. 18.

Plate Efficiency: Estimate the local dry vapor efficiency based on past experience, or by means of the Geddes[12] method. Correct for entrainment by Equation 65. Correct for liquid concentration gradient by Equation 66, wherein the number of stages is estimated from Fig. 20.

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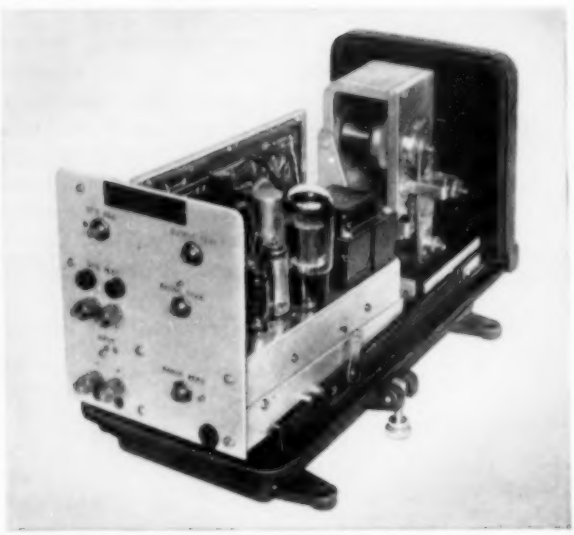

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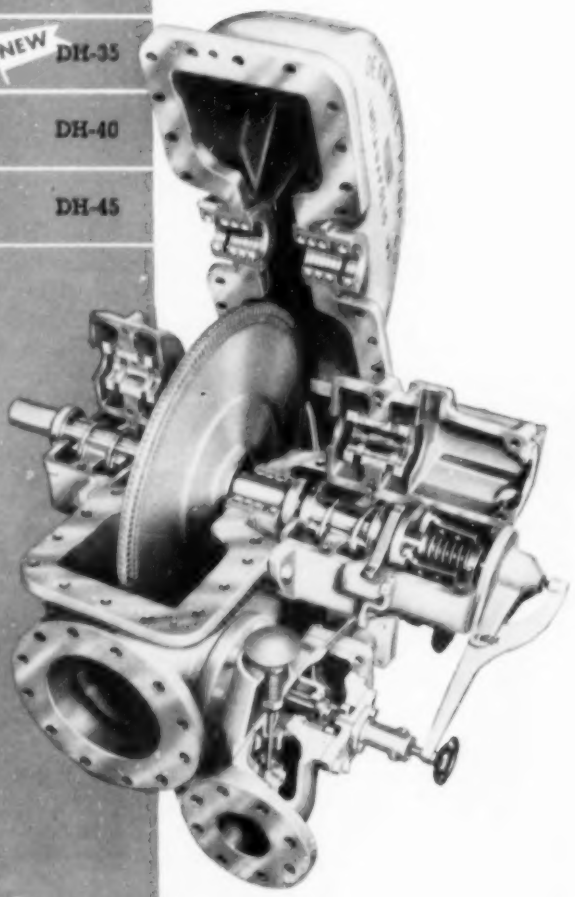

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New Flaw Detector Is Safe Tool

Designed for use in hazardous areas where electrical arcing cannot be tolerated, this tester uses a permanent magnet to detect and locate surface or fatigue cracks in metal. See What's New for this and over 50 other new ideas. **p. 125**

Is Our Patent System Outdated?

Why does it take so long for good ideas to get through the maze of technicalities? These new products of America's inventive minds are flowing at ever-increasing rates, yet it still takes months. Why? asks the Editorial. **p. 156**

INDEX TO ALL DEPARTMENTS

"Clip-n-File" Process Data	89
Plant Practices	93
Operating Trends	97
"Clip-n-File" Engineering Data	101
Personals	103
New Words in Your Reading	104
Patents	107
Suppliers	113
Meetings Calendar	115
New Books	117
Information Offered	120
Advertisers' Index	122
Readers' Service Card	123
What's New!	125
Editorials	156

Phenol at 350° F.
no problem for these Crane Valves

THE CASE HISTORY—Refinery men know that handling hot phenol can be rough on valves and cause a lot of headaches. Or it can be a smooth, efficient valve operation—year in and out—as experienced here at the Continental Oil plant at Ponca City.

These Crane No. 47X 150-pound cast steel gate valves are on phenol service at 60 psi., 350° F. They're on the exhaust line from extraction tower bottoms pump in the aromatic extraction unit.

Installed in 1944, these Crane valves have required only routine maintenance. Operated about twice a month—they continue to make tight closure with ease—with no leakage or sticking.

Outwardly Crane valves may look like many others. But it's a mistake to assume all steel gate valves are alike.

The difference that's most important to you is inside—for instance, in the extra skill and care that goes into Crane seating design and materials. That's what makes Crane valves such outstanding performers on refinery services.

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Process—Direct production of ethylene by steam-pyrolysis of petroleum feeds (from refinery gas to heavy gas oil fractions).

Process Flow—The accompanying flow diagram is representative of an actual commercial installation making ethylene from crude oil feed stock.

Starting with the crude oil it is topped in an atmospheric tower to produce:

1—Light straight-run gasoline which goes to the final gasoline blend.

2—Heavy naphtha and gas oil which go to the steam-pyrolysis unit.

3—Reduced crude which goes to a visbreaker for viscosity reduction to give a salable fuel oil. Gasoline from the visbreaker can be fed to the pyrolysis unit.

Heavy naphtha and gas oil from atmospheric topping are pumped through the preheater coils in the furnace, then mixed with steam superheated in separate furnace coils. Following the mixing step, the remaining liquid is removed in a flash drum and sent to the fuel oil blend.

Mixing steam with the hydrocarbon feed reduces the partial pressure of the oil in the flash drum to a point where the feed can be substantially vaporized at a comparatively low temperature that will produce negligible cracking, and reduces the partial pressure of the oil in the high-temperature pyrolysis step, thus insuring a higher percentage of feed cracking and increased yield of desired products.

Combined hydrocarbons and steam flow through the high-temperature coils in the pyrolysis furnace, where cracking takes place. After cracking, hot gases flow through a quench boiler system which generates sufficient steam to meet all cracking requirements as well as some steam for compressor drives.

Leaving the quench boiler, steam plus cracked products of pyrolysis flow to a primary fractionator tower where motor gasoline and lighter material are taken overhead, and bottoms are heavy material used as fuel oil. Process steam condensed in the fractionator overhead system is stripped of oil by low pressure steam, the resulting hydrocarbons being returned to the primary fractionator overhead condenser oil phase.

Overhead from the primary fractionator is charged to the recovery system where the various components are separated.

This overhead stream is first fractionated in the primary depropanizer, with bottoms from the depropanizer being charged to the debutanizer.

Debutanizer overhead contains butylene and butadiene which can be profitably separated as petrochemical raw materials. Debutanizer bottoms can be processed to recover aromatics, such as benzene, toluene, xylenes, etc., or can be used to upgrade the combined topping unit-visbreaker gasoline blend.

Overhead from the primary depropanizer is first desulfurized in a DEA unit, then dried in fixed-bed driers, then charged to the catalytic acetylene converters. In these converters, acetylene is converted into additional ethylene by use of the hydrogen already in this process stream resulting from the cracking step.

Following the acetylene converters, the stream enters the secondary depropanizer, the bottoms of which serve as reflux for the primary depropanizer.

Secondary depropanizer overhead next goes to the low-temperature fractionation system consisting of a de-methanizer, a de-ethanizer and a C_2 splitter.

De-methanizer overhead contains methane, hydrogen, etc. which goes to fuel gas. Bottoms go to the de-ethanizer.

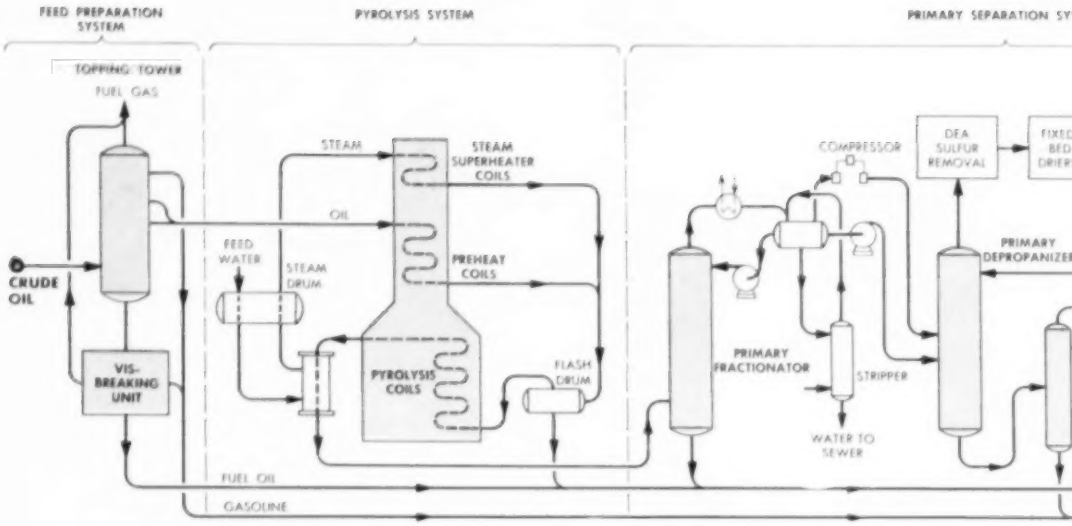
De-ethanizer overhead is sent to the C_2 splitter to give bottoms of ethane and an overhead of the final ethylene product. De-ethanizer bottoms provide a propylene stream.

Raw Materials—Feed stock for making ethylene may be ethane, propane, natural gasoline, naphtha or gas oil. A unit may be designed to process any predetermined combination of the above feeds by incorporation of added refinements.

Though primary emphasis in the U.S. has been to produce ethylene from ethane and propane—since these gases are available in large volumes from refinery and natural gases—crude oil may be used as the feed stock, if prepared by the

Typical product distribution for steam-pyrolysis of crude oils

	Severe Cracking				Mild Cracking			
	Volume % on crude	Weight % on crude	°API	Sulfur weight %	Volume % on crude	Weight % on crude	°API	Sulfur weight %
Crude oil	100.0	100.0	36.2	2.0	100.0	100.0	36.2	2.0
Ethylene	—	17.0	—	0	—	11.0	—	0
Propylene	17.3	10.7	—	0	16.6	10.2	—	0
Butylene-butadiene	8.9	6.6	—	—	7.2	5.7	—	—
Gasoline	20.2	—	55.3	0.34	29.7	—	45.6	0.38
Heavy fuel oil	35.4	—	2.3	3.5	30.9	—	9.5	3.4
Fuel gas	—	13.6	—	—	—	8.9	—	—



petroleum processing steps shown on the flow diagram.

Operating Conditions—Typical operating conditions for steam-pyrolysis of the virgin naphtha-gas oil blend are: hydrocarbon preheat temperature 1100-1250°F., superheated steam temperature 1200°F., and quench system temperature 400-500°F. In the production of light hydrocarbons, refrigeration temperatures ranging from −15 to −210°F. are needed, depending upon the product being made from the low-temperature fractionation system.

The production of various quantities and ratios of light olefins by steam pyrolysis is dependent upon the cracking temperatures and the steam to hydrocarbon ratio.

Product—Ethylene from the equipment shown in the flow diagram will be about 98.5% pure, and is suitable for many petrochemical operations. If 99.9% purity is required, then additional fractionator columns would be needed.

As mentioned before, the butylene-butadiene by product can be used for petrochemical production. Motor gasoline, composed of straight-run, visbreaker and pyrolysis gasoline is a salable product of relatively high quality. Fuel oil, made of visbreaker tar and pyrolysis tar is also salable.

Approximate product distributions for mild and severe steam-pyrolysis, starting from crude, are shown in the table of typical product distribution.

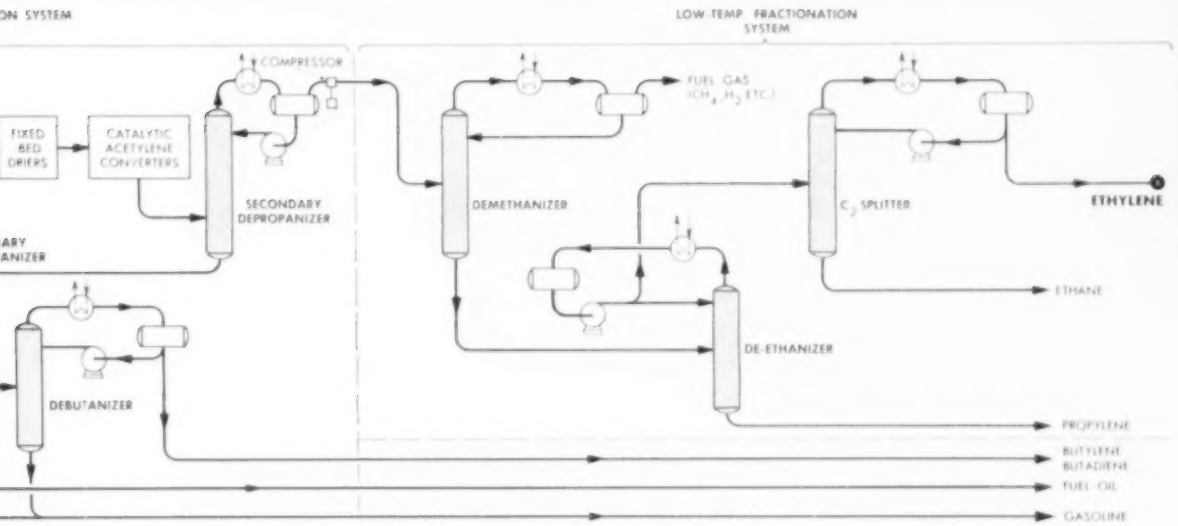
With heavy naphtha and gas oil feeds, ethylene yields as high as 32 and 26 weight % respectively have been obtained. The heavy feeds also give a high degree of flexibility in the production of other olefins and aromatics.

Equipment—Two pyrolysis furnaces are used. Each furnace contains a pyrolysis radiant section

Over-all economic survey—severe cracking of 5000 bpsd paraffinic crude oil

	Unit value	bpsd	bpsd	lb./sd	lb./cd	$/cd
Product credits						
Gasoline, ¢/gal.	13.5	1010	989			5,154
Ethylene, ¢/lb.	5			250,400	225,400	11,270
Propylene, ¢/gal.	8.5	865	778			2,779
Butylene-butadiene, ¢/gal.	24	445	400			4,037
Fuel gas, F.O.E., ¢/bbl.	220	719	647			1,424
Heavy fuel oil, ¢/bbl.	220	1272	1145			2,519
Total credits						27,183
Debits						
Crude, delivered, ¢/bbl.	323	5000	4500			14,535
Direct operating costs						3,856
Maintenance at 4% of investment						1,096
Property taxes & insurance at 3% of investment						822
Interest at 4% of investment						1,096
Total debits						21,405
Net credits*						5,778
Net credits, $/year*						2,108,970
Estimated investment (process equipment only)						10,000,000
Total debits less by-product credits, $/cd						5,492
Ethylene manufacturing cost, ¢/lb.						2.44

*Before taxes and depreciation



Ethylene

By Steam-Pyrolysis of Petroleum Stocks

UNFOLD FOR START OF PROCESS DESCRIPTION

designed for the desired amount of cracking. The convection bank of each furnace is used to superheat high-pressure steam and to preheat the pyrolysis feed.

Steam generation may be optionally included in the pyrolysis furnace and used to drive compressor turbines and pumps in the ethylene unit.

In one typical application, two stages of process gas compression, which precede the depropanizer, as well as the final stage, which lies just beyond the depropanizer reflux drum, share a common gas-engine driver. By installation of identical, three-stage compressors in parallel, each with its own gas engine driver and each designed to handle slightly more than its proportion of the normal operating load, a wide range of plant capacities may be handled, up to 20% in excess of the estimated maximum for normal operations.

The split-tower depropanizer design with drying of the secondary depropanizer feed lets the tower top operate at a refrigerated low pressure. This minimizes work of compression used on butylene and heavier in the vapor fraction of the primary depropanizer feed, and—with the driers between the two sections—avoids the need for liquid phase drying. Also the low temperature largely prevents the formation of polymers at that point.

Utilities—Manpower and utilities consumption would be about $3856/cd for an East Coast plant producing ethylene from 5000 b/sd paraffinic crude oil.

Economics—For ethylene production in a plant processing 5000 b/sd of paraffinic crude oil, economics are given in the accompanying table.

Installations—M. W. Kellogg has three operating installations, one each in England, Canada and Italy. Feed stocks vary from refinery gas to crude oil. Two other plants are under construction, one in the United States.

Licensing—No licensing arrangements are needed for the plant described. Engineering, design and construction of this type plant can be had from the M. W. Kellogg Co., 225 Broadway, New York City.

References—Information published about the Kellogg steam pyrolysis process includes:

(1) King, Charles C., and James Warburton, "More Efficient Ethylene Production," PETROLEUM PROCESSING, Nov. 1952, pp. 1644-47.

(2) Chemical Process Div., The M. W. Kellogg Co., "Better Yields, Higher Purity from Ethylene Plants by M. W. Kellogg," 1955.

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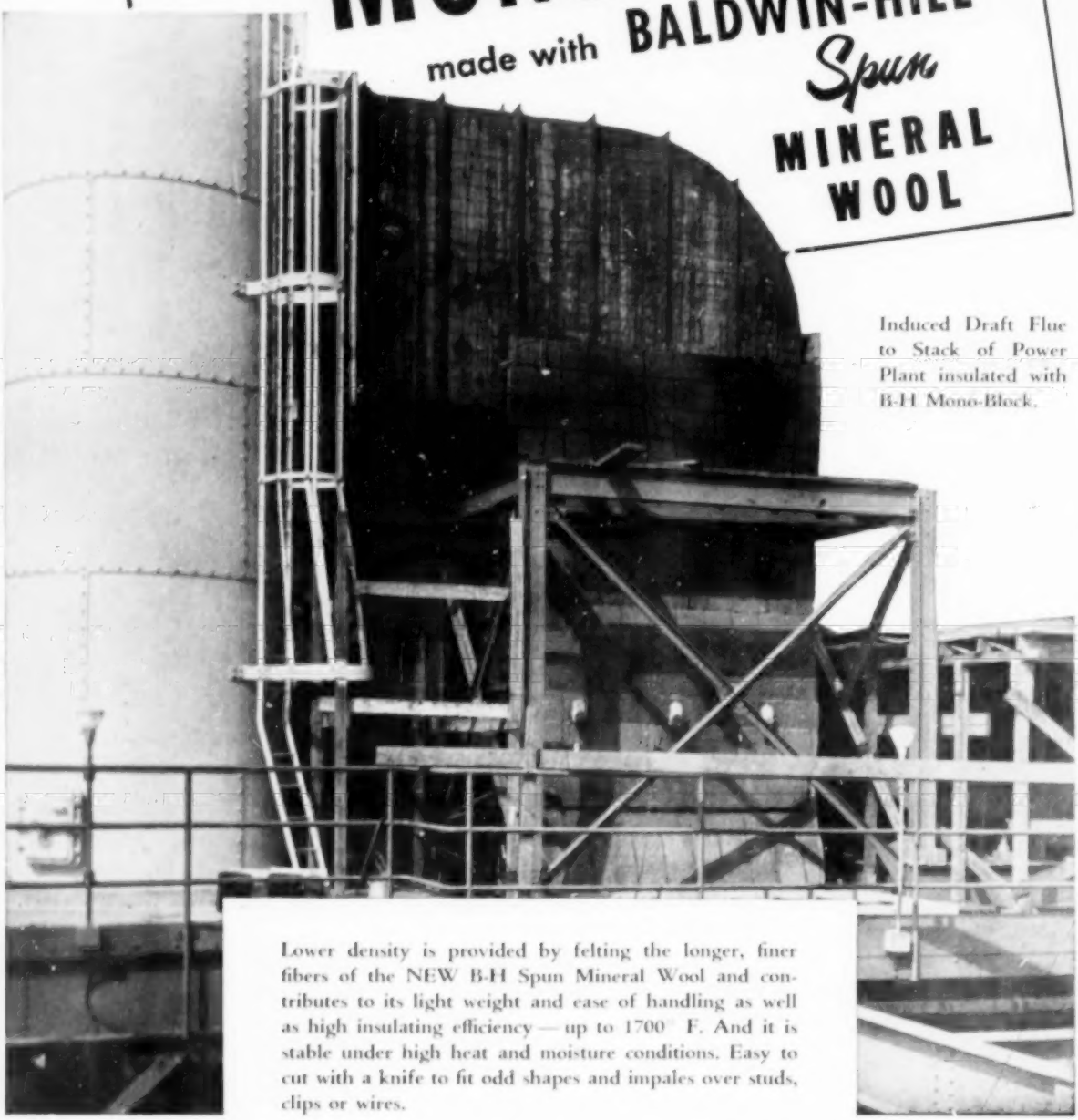
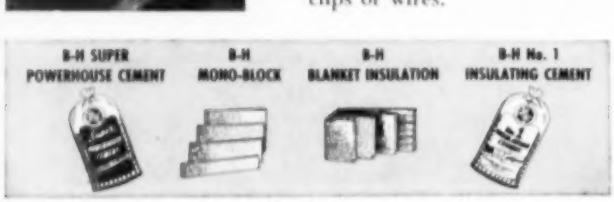
made with BALDWIN-HILL *Spun* MINERAL WOOL



Induced Draft Flue to Stack of Power Plant insulated with B-H Mono-Block.

Lower density is provided by felting the longer, finer fibers of the NEW B-H Spun Mineral Wool and contributes to its light weight and ease of handling as well as high insulating efficiency — up to 1700° F. And it is stable under high heat and moisture conditions. Easy to cut with a knife to fit odd shapes and impales over studs, clips or wires.



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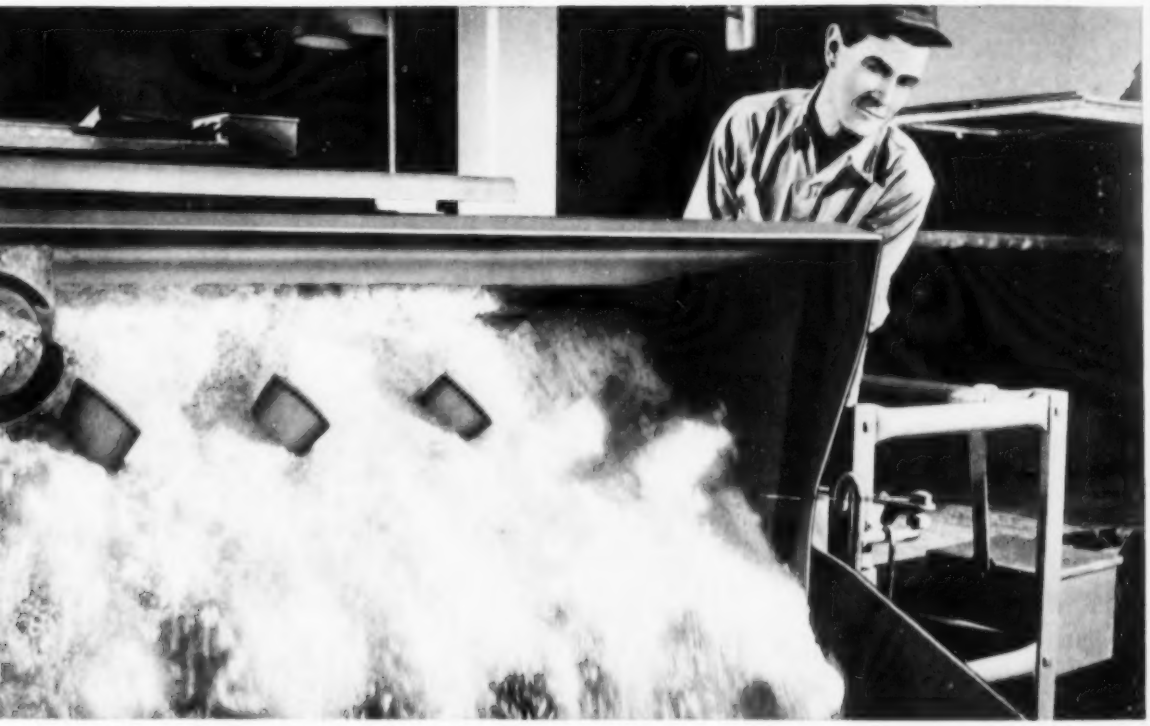

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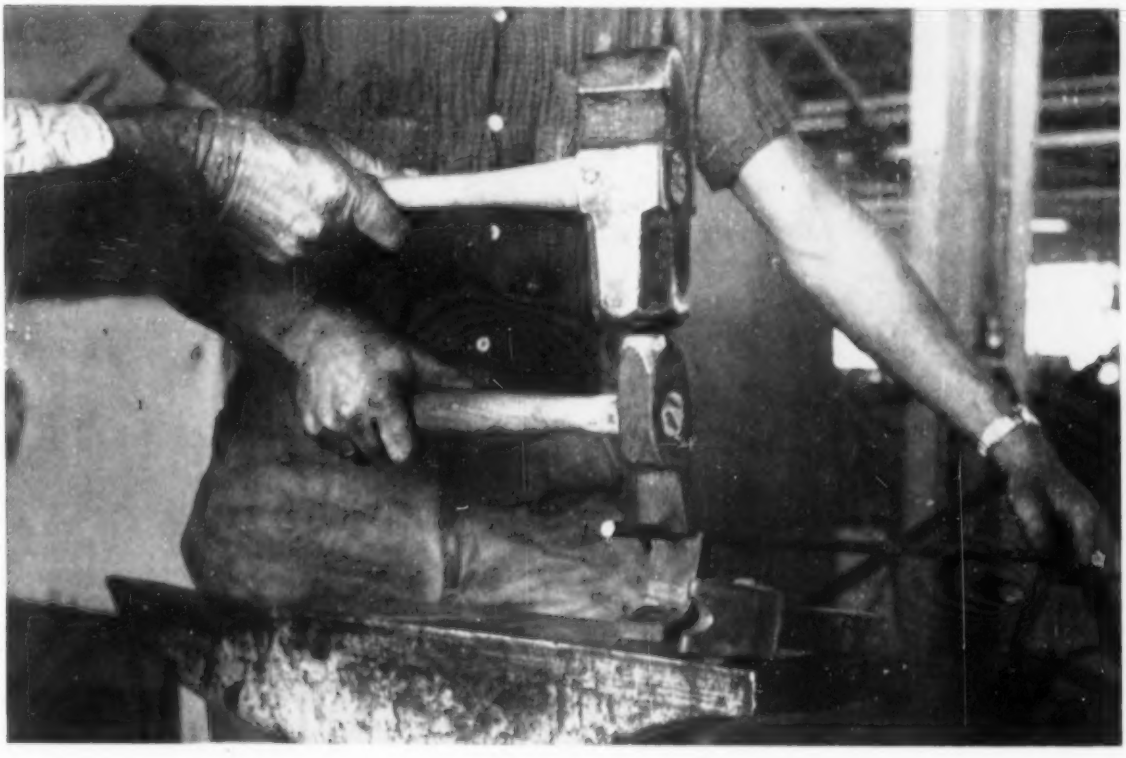


Special Tool Speeds Rod Cutting

A STANDARD blacksmith's cutting tool—slightly modified—a good small rod cutter for the shop. Faster to use than the power hacksaw, it does a good job on the smaller rods. For large sizes it is not advisable, since it results in considerable distortion of the cut rod.

This tool, developed by the shop blacksmith at Cosden Petroleum Corp.'s Big Spring, Texas, refinery is in two parts. One is forged to fit the anvil and has a U-shaped, sharp-edged notch. The mating part is forged from one end of a heavy hammer and is similarly shaped. The cutting force is provided by a common sledge hammer.

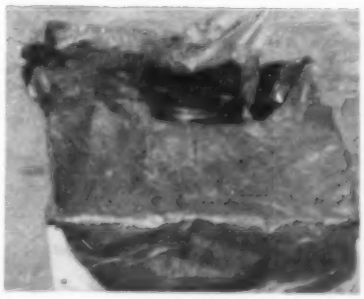
One of the tools is placed on an anvil or in a heavy vise, with the rod placed in the saddle slot. The converted hammer is placed on top of the rod. The descending sledge, usually wielded by a helper, completes the cutting with a sharp stroke.

Rods up to ½-in. diameter can be cut in the cold state, as rapidly as they are placed in the tool. (Note the round end on the freshly-cut rod in above photograph.)

Special Paper Protects Metal

FOLLOWING repair or machining of small equipment parts for valves, etc., the new surface must be protected from atmospheric corrosion until they can be re-applied in their intended process service.

The machine shop at Shell Oil Co.'s Wood River, Ill., refinery has found that by wrapping these small items in a special self-sealing paper containing Shell's VPI* crystals, the repaired part can be stored for long periods, yet not be corroded when required for installation.



VPI powder may be applied to the inside of cleaned pipes, tubes, etc., along with normal protection of the ends to prevent excessive water entrance and dilution of the developed vapors with air. The product is effective only if the air, which is in contact with the metal surface to be protected, is saturated with the vapor.

It has been considered for protection of internal storage tank surfaces

*Trademark registered U.S. Patent Office.

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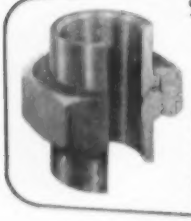

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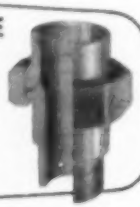

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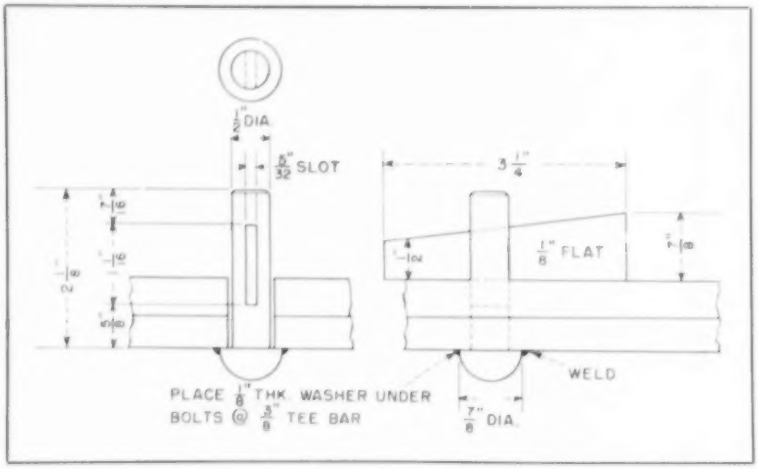
of refinery tanks up to 50,000 gal. capacities. Application involves distribution of the powder by dusting all tank surfaces with a floc gun. Then sheets of paper, coated with the powder, are suspended the length of the tank to insure saturation of air. Breather holes in the tank are fitted with plugs also containing the powder so that air saturation is maintained during temperature changes.

It is essential that all surfaces to be protected are effectively neutralized by water washing, etc., and drying prior to introduction of the material.

Wood River Refinery uses VPI in both powder and coated paper form for preservation of the following items in their stores: Engine parts and shafts, tool parts, pump shafts, compressors and tube bundles. Both indoor and outdoor storage are included. For the latter, the part is further protected by covering with tarps.

This product was the outcome of research at Shell Development Co.



Tower Tray Fasteners Come Apart

By R. J. SCHMIDT*

PERHAPS one of the most frustrating tasks of the maintenance gang is the disassembly and overhaul of a fractionating tower. Too often there is extreme difficulty in removing the manways and trays, for the bolts holding them have become frozen. Many times as a last resort they must be burned out with an acetylene torch. But this is a procedure that for safety reasons should be avoided in any refinery.

An alternate method for fastening the trays and manways in a tower is the use of slotted bolts and keys. Installation is simple, and "freezing" is seldom encountered. Even after extended service, manways and trays can be removed readily.

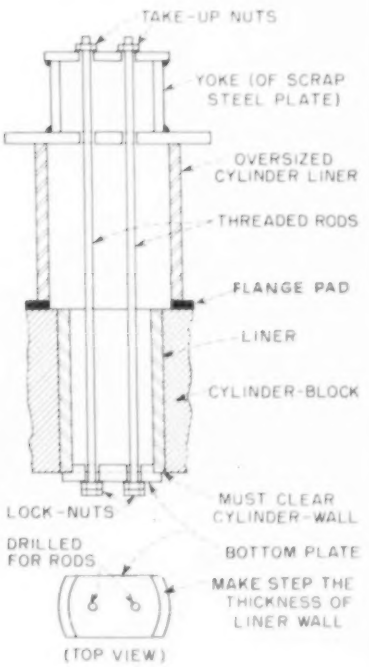
*Mr. Schmidt is a civil engineer at Sinclair Refining Co.'s Marcus Hook, Pa., refinery.

Pulling Cylinder Liners Made Easy

THIS jig makes it easy to pull cylinder liners, without the use of block and tackle or a chain hoist. Developed by the mechanical department of Socony Mobil Oil Co.'s East St. Louis, Ill., refinery, the jig will work on any size cylinder where the bottom of the liner is readily accessible.

The device consists of three main parts: (1) a yoke on a drilled plate big enough to cover the largest cylinder liner likely to be met, (2) two threaded rods with nuts to fit, and (3) a bottom plate of heavy steel bar-stock, into which the threaded rods fit.

In practice, several bottom plates fitting the various sizes of cylinders work with a single yoke. The rods must be twice the length of the largest liner to be pulled—plus the length of the yoke and thickness of the rod-nuts. The jig is put together as shown



in the drawing shown directly above.

To pull a liner this procedure is followed:

Secure a second, oversize liner at least as long as the liner to be pulled. Place it concentrically over the one to be pulled, allowing it to rest on the cylinder block. Mount the yoke on top of this liner.

Next, place the bottom plate in contact with the liner being pulled and install the rods through it. Install the nuts on the rods and "take up" until the bottom plate is firmly seated, with both ends bearing firmly on the bottom of the liner being pulled. Then by running the two nuts down evenly on the rods, the old liner is pulled free.

To speed up the pulling operation, Socony Mobil has used a 200-ton hydraulic cylinder. When the hydraulic ram reaches the end of its travel, the nuts are readjusted for a new "pull." Using this method may require anywhere from 50 to 120 tons of force.

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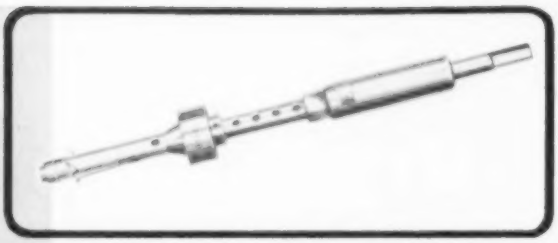

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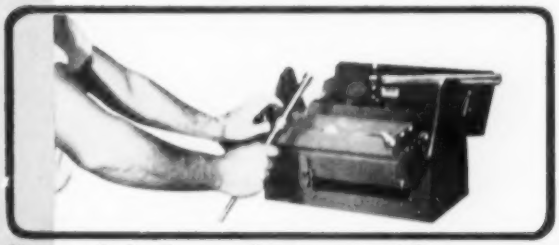
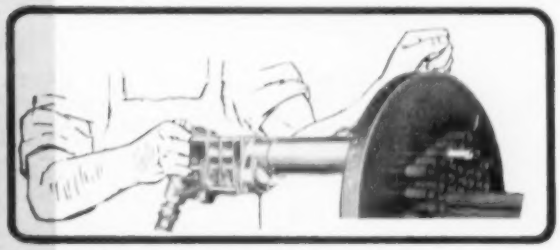


Easily carried. A must in every tool box.

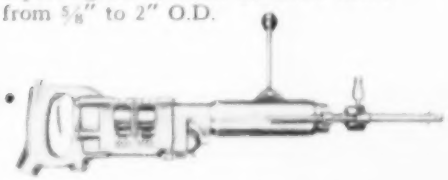
Many uses in every plant. Action of cutting blades is produced by pushing cutter into the tube which automatically opens the double cutter blades.



Works wonders when replacing tubes

Extremely useful. Saves time when replacing worn, small diameter tubes from $\frac{5}{8}$" to 2" O.D.

Also furnished with motor and lever operator



An air-driven type internal tube cutter is available for production use. Cuts non-ferrous tubes 2-4 seconds each. Steel tubes 8-12 seconds each. Literature and complete details upon request.

BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

Representatives in principal cities of U.S.A., Canada, Mexico, England, South America and Japan.

EUROPEAN PLANT: Airetool Nederland, N.V., Vlaardingen, The Netherlands.

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ELIMINATES PRODUCTION OF HEAVY RESIDUAL FUEL

- Over 2 years refinery experience
- No heavy metal contamination problem
- Uses synthetic or natural clay catalysts

The Houdresid Process eliminates the production of heavy residual fuel by making it practical and economical to catalytically crack the bottom of the petroleum barrel. This refinery-proved, continuous moving bed process converts reduced crudes into exceptional yields of high-octane gasoline and light distillate fuel. The process is well adapted to the use of synthetic or natural clay catalyst, and to the charging of a wide range of reduced crudes.

The problem of heavy metal contamination usually associated with catalytic cracking of residua has been successfully eliminated by the Houdresid process. This has been conclusively demonstrated in both pilot plant and commercial refinery operations. One commercial Houdresid unit has been in operation for over 2 years.
Write today for further information.

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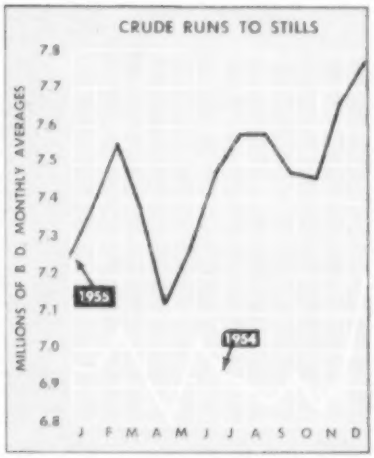
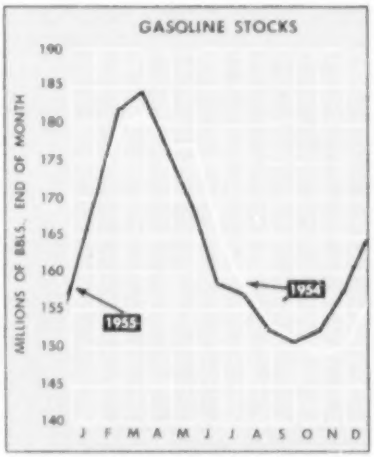
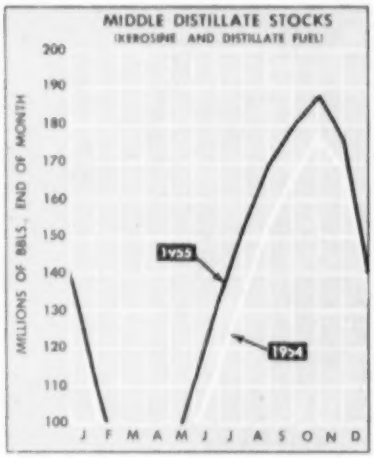






1955 Figures to Dec. 30

Distillate Supply Held Adequate

OUTLOOK: For crude runs to exceed the 7,730,000 b/d forecast for the first quarter of 1956, perhaps to reach 8,000,000 b/d.

CRUDE runs to stills have steadily increased, reaching 7,760,000 b/d avg. in December, over 7% larger than in December, 1954, and higher than the forecast of 7,730,000 b/d avg. for the first quarter of 1956. Stimulated by the severe early winter in the upper midwest, runs in the Ind.-Ill.-Ky. district were 10% larger than in December, 1954. A continuing heavy demand for distillate fuel oil may push overall runs higher.

Distillate fuel oil demand for the last quarter of 1955 was 10% greater than for the last 3 months of 1954, due both to the larger market and the colder than normal early winter. Refiners' inventories were 143,250,000 bbls. Sept. 30, 12% larger than the year before. By Dec. 30 they had been reduced to about 113,000,000 bbls., only 3% larger. With the higher plant output, stocks are considered adequate, unless the latter part of the winter is unusually severe.

Distillate fuel oil demand for the first quarter of 1956 is forecast at 2,430,000 b/d avg. This is 20% larger than the estimated demand of 2,017,000 b/d for the last quarter of 1955. Demand increased 22% from the last quarter of 1954 to the first of 1955.

Buildup in gasoline inventories has been stimulated by the higher crude runs, even though demand is running well ahead of a year ago. The middle of October, U.S. inventories were about the same as the year before, around 150,500,000 bbls. By Dec. 30 they were about 165,000,000 bbls., compared with 157,228,000 bbls. Dec. 31, 1954. They are headed for a peak March 31, considerably over the 188,000,000 bbls. forecast as adequate for anticipated spring and summer needs.

The tight residual fuel oil supply is stimulating refinery output, at East and Gulf Coast refineries particularly. Total U.S. plant output in December was 6.4% larger than in December, 1954. Refiners' stocks east of California remain under 28,000,000 bbls., but they are about 5,000,000 bbls. larger than a year ago.

DECEMBER KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	1955*	1955	1954
CRUDE OIL			
U. S. Production	6.953	6.831	6.394
Imports	.852	.820	.729
U. S. Stocks	262.033	257.711	258.385
Runs to Stills	7.764	7.664	7.238
GASOLINE			
Refinery Output	3.854	3.756	3.515
Refinery Demand	3.694	3.686	3.455
Primary Stocks	164.859	157.059	155.400
MIDDLE DISTILLATES			
Refinery Output	2.129	2.016	2.049
Refinery Demand	3.292	2.451	3.112
Primary Stocks	140.229	175.143	135.970
RESIDUALS			
Refinery Output	1.263	1.175	1.187
Imports	.531	.409	.527
Total Supply	1.794	1.584	1.714
Refinery Demand	1.945	1.642	1.820
Primary Stocks	39.872	44.410	52.105

*Through Dec. 30

PRODUCT AND CRUDE PRICES

(Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service

	Dec. 1955*	Nov. 1955	Dec. 1954
Gasoline (regular)	11.81	11.81	11.22
Distillate Fuel Oil	9.11	8.93	9.06
Kerosine	10.51	10.35	10.56
Residuals	4.96	4.84	4.08
Above 4 Products	9.29	9.22	8.72
Lube Oils	20.44	20.28	16.46
Crude	2.83	2.83	2.81

REFINERY YIELDS

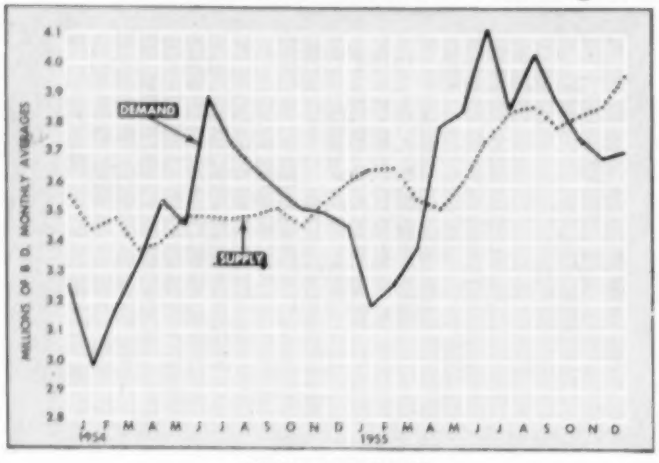
% on Crude Runs to Stills

	Dec. 1955*	Nov. 1955	Dec. 1954
Gasoline	45.4	44.4	43.7
Kerosine	4.6	4.3	5.2
Distillate	22.8	22.0	22.9
Residuals	16.3	15.3	16.3

*Through Dec. 30

SOURCE OF DATA (except prices): Nov., Dec., and Jan., API weekly reports; earlier months, Bureau of Mines

Gasoline Demand is Holding Well Above Last Winter

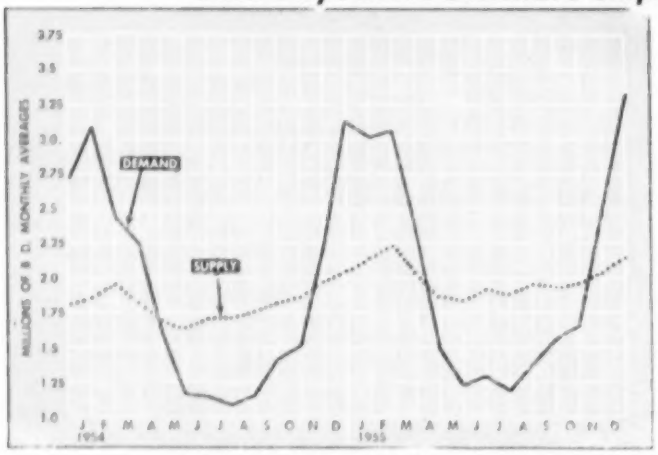


1955 Figures to Dec. 30

MOTOR FUELS

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Dec. '55	3.524	.430	3.954
Dec. '54	3.190	.415	3.605
Change	+ .334	+ .015	+ .349
% Change	+ 10.5	+ 3.6	+ 9.7
DEMAND (including Exports) (Millions of b/d)			
Dec. '55			3.694
Dec. '54			3.455
Change			+ .239
% Change			+ 6.9
TOTAL SUPPLY (Millions of bbls.)			
12 Mos. '55	1,206.565	155.592	1,362.157
12 Mos. '54	1,115.440	153.712	1,269.152
Change	+91.125	+ 1.880	+ 93.005
% Change	+ 8.2	+ 1.2	+ 7.3
TOTAL DEMAND (including Exports) (Millions of bbls.)			
12 Mos. '55			1,355.306
12 Mos. '54			1,272.809
Change			+ 82.497
% Change			+ 6.5

Cold Days Drive Distillate Shipments to New High

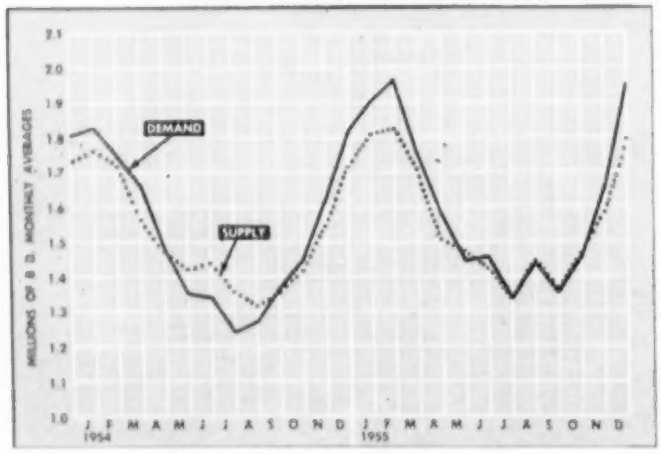


1955 Figures to Dec. 30

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Dec. '55	.360	1.769	2.129
Dec. '54	.381	1.668	2.049
Change	−.021	+ .101	+ .080
% Change	− 5.5	+ 6.1	+ 3.9
DEMAND (including Exports) (Millions of b/d)			
Dec. '55	.563	2.729	3.292
Dec. '54	.597	2.515	3.112
Change	−.034	+ .214	+ .180
% Change	− 5.7	+ 8.5	+ 5.8
TOTAL PRODUCTION (Millions of bbls.)			
12 Mos. '54	117.837	602.259	720.096
12 Mos. '54	122.305	542.278	664.583
Change	− 4.468	+ 59.981	+ 55.513
% Change	− 3.7	+ 11.1	+ 8.3
TOTAL DEMAND (including Exports) (Millions of bbls.)			
12 Mos. '55	118.278	604.746	723.024
12 Mos. '54	123.163	550.570	673.733
Change	− 4.885	+ 54.176	+ 49.291
% Change	− 3.9	+ 9.9	+ 7.3

Higher Plant Output, Imports, Boost Residual Supply



1955 Figures to Dec. 30

RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Millions of b/d)			
Dec. '55	1.263	.531	1.794
Dec. '54	1.187	.527	1.714
Change	+ .076	+ .004	+ .080
% Change	+ 6.4	+ 0.8	+ 4.7
DEMAND (including Exports) (Millions of b/d)			
Dec. '55			1.945
Dec. '54			1.820
Change			+ .125
% Change			+ 6.9
TOTAL SUPPLY (Millions of bbls.)			
12 Mos. '55	419.440	149.660	569.100
12 Mos. '54	416.757	129.009	545.766
Change	+ 1.683	+ 20.651	+ 22.334
% Change	0.4	16.0	+ 4.1
TOTAL DEMAND (including Exports) (Millions of bbls.)			
12 Mos. '55			584.059
12 Mos. '54			548.955
Change			+ 35.103
% Change			+ 6.4

SOURCE OF DATA: Nov., Dec., and Jan., API weekly reports; earlier months, Bureau of Mines

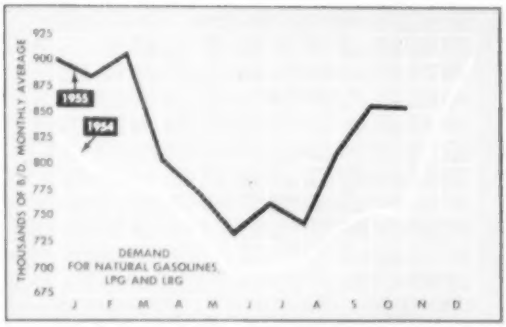
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

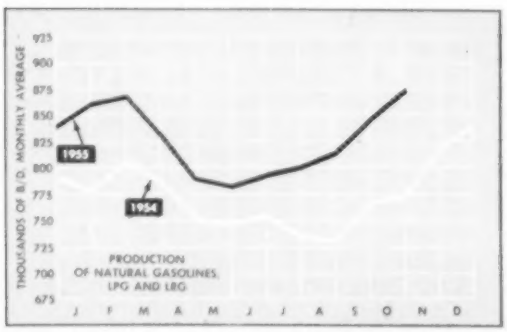
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change	GASOLINE STOCKS (Millions of bbls. on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change	RESIDUAL STOCKS (Millions of bbls. on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change
East Coast	1.095	1.013	+ .082	+ 8.1	35.724	32.441	+ 3.283	+10.1	11.497	9.171	+ 2.326	+25.4
Gulf Coast	2.654	2.424	+ .230	+ 9.5	32.313	34.101	− 1.788	− 5.2	8.106	5.655	+ 2.451	+43.3
Total Coastal	3.749	3.437	+ .312	+ 9.1	68.037	66.542	+ 1.495	+ 2.2	19.603	14.826	+ 4.777	+32.2
Appalachian	.214	.186	+ .028	+15.0	6.990	6.855	+ .135	+ 2.0	.815	.764	+ .051	+ 6.7
Ind.-Ill.-Ky.	1.514	1.346	+ .168	+12.5	34.179	34.470	− .291	− 0.8	3.778	3.518	+ .260	+ 7.4
Okla.-Kans.-Mo.	.761	.660	+ .101	+15.3	17.614	15.224	+ 2.390	+15.7	1.335	1.251	+ .084	+ 6.7
Other Inland	.654	.602	+ .052	+ 8.6	16.166	15.656	+ .510	+ 3.3	2.132	2.321	− .189	− 8.1
Total Inland	3.143	2.794	+ .349	+12.5	74.949	72.205	+ 2.744	+ 3.8	8.060	7.854	+ .206	+ 2.6
Total East of Calif.	6.592	6.231	+ .661	+10.6	142.986	138.747	+ 4.239	+ 3.1	27.663	22.680	+ 4.983	+22.0
California	1.015	1.065	− .050	− 4.7	21.873	18.491	+ 3.392	+18.4	12.209	28.681	−16.472	−57.4
Total U. S.	7.907	7.296	+ .611	+ 8.4	164.859	157.228	+ 7.631	+ 4.9	39.872	51.361	−11.419	−22.4

District	DISTILLATE FUEL OIL STOCKS (Millions of bbls. on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change	KEROSINE STOCKS (Millions of bbls. on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbls. on date shown) Dec. 30 1955	Dec. 31 1954	Change	% Change
East Coast	41.367	38.803	+2.564	+ 6.6	11.323	11.655	− .332	− 2.8	52.690	50.458	+ 2.232	+ 4.4
Gulf Coast	19.488	18.678	+ .810	+ 4.3	5.464	5.266	+ .198	+ 3.8	24.952	23.944	+ 1.008	+ 4.2
Total Coastal	60.855	57.481	+3.374	+ 5.9	16.787	16.921	− .134	− 0.8	77.642	74.402	+ 3.240	+ 4.4
Appalachian	3.052	2.811	+ .241	+ 8.6	1.044	1.008	+ .036	+ 3.6	4.096	3.819	+ .277	+ 7.3
Ind.-Ill.-Ky.	19.296	19.580	− .284	− 1.5	6.375	7.692	− 1.317	−17.1	25.671	27.272	− 1.601	− 5.9
Okla.-Kans.-Mo.	11.685	11.577	+ .108	+ 0.9	1.452	1.958	− .516	−26.2	13.137	13.545	− .408	− 3.0
Other Inland	7.020	5.750	+1.270	+22.1	1.394	1.272	+ .122	+ 9.6	8.414	7.022	+ 1.392	+19.8
Total Inland	41.053	39.718	+1.335	+ 3.4	10.265	11.940	− 1.675	−14.0	51.318	51.658	− .340	− 0.7
Total East of Calif.	101.909	97.199	+4.709	+ 4.8	27.052	27.861	− 1.809	− 6.3	123.960	126.060	+ 2.900	+ 2.3
California	10.884	12.432	−1.548	−12.5	.385	.420	− .035	− 8.3	11.269	12.852	− 1.583	−12.3
Total U. S.	112.792	109.631	+3.161	+ 2.9	27.437	28.281	− 1.844	− 6.3	140.229	138.912	+ 1.317	+ 1.0

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	Oct. 1955	Sept. 1955	Oct. 1954
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	381	357	332
Natural Gasoline and Isopentane	283	287	274
Condensate	21	21	24
Finished Gasoline, Naphtha and other	62	61	62
Total Natural Gasoline and Cycling Plant Production	747	726	692
Liquefied Refinery Gases	129	122	80
Total Marketable Gas Liquids	876	848	772
Lease Condensate	114	108	96
Total Natural Gas Liquids	990	956	868
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	491	479	394
Natural Gasoline, Isopentane and other	365	380	358
Total Marketable Gas Liquids	856	859	752
CUMULATIVE PRODUCTION (1000 bbls.)	**Oct. 1955**		**Oct. 1954**
LPG and LRG	141,632		124,573
Natural Gasoline, Isopentane and Other	109,824		107,098
Total Marketable Gas Liquids	251,456		231,671
CUMULATIVE DEMAND (1000 bbls.)			
LPG and LRG	136,846		149,844
Natural Gasoline, Isopentane and Other	110,494		129,411
Total Marketable Gas Liquids	247,340		279,255

STOCKS (1000 bbls., end of month)	Oct. 1955	Sept. 1955	Oct. 1954
LPG and LRG	12,544	11,978	10,271
Natural Gasoline, Isopentane and Other	4,456	4,401	4,809
Total Stocks	17,000	16,379	15,080

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Temperature—Fundamentals

DEFINITION: Temperature is an arbitrary measurement of the amount of molecular energy of a body—or the degree of heat possessed by it. It should be distinguished from heat itself. Heat is a form of energy; temperature is a measurement of its intensity.

WHAT CAUSES IT: Since temperature is a measurement of the degree of one form of energy, it depends entirely on increases or decreases in that energy. In molecular terms a change in energy means a change in the average velocity of all molecules of a body—an increase in its internal energy.

Such increases in energy are due to the transfer of heat from another body possessing more—or the translation of other forms of energy into heat. (The most striking example is the translation of energy involved in a thermonuclear explosion.)

RELATIONSHIP TO OTHER VARIABLES: Temperature resembles pressure in that it measures energy levels. For an ideal gas the two are related by the formula:

$$T = PV / \text{constant}$$

T = Temperature P = Pressure V = Volume

In dealing with everyday materials (solids and liquids) there is no simple relationship of temperature with other measurables. It is only in comparing levels of energy that temperature as a quantity can be used.

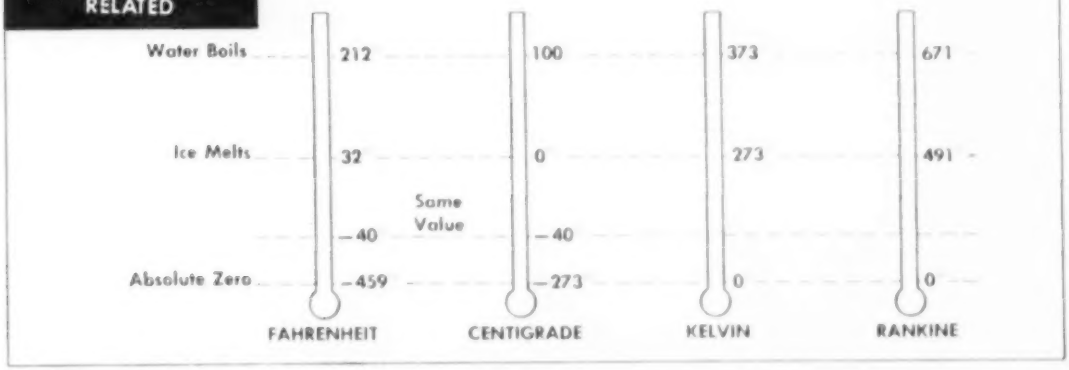
However, everything is affected in some way by temperature changes—expansion, conductivity, electrical resistance, melting and boiling, etc.—even the chirps per minute of a cricket. Measuring these secondary effects is the basis of all temperature comparisons.

HOW IT IS MEASURED: Since temperature is measured by its effect on other variables there are many possible systems. The most commonly used are:

Principle	Instrument
Expansion of solids, liquids, or gases	Thermometers (liquid column)
Pressure changes of constant volumes	Dial thermometers
Electrical resistance changes	Resistance thermometers
Thermoelectric (Seebeck) effect	Thermocouples
Brightness of heated bodies	Optical pyrometer
Thermal radiation from heated bodies	Radiation pyrometer

For normal refining temperatures, thermometers (liquid column, dial and resistance) and thermocouples are used—each where its advantages can best be used.

HOW TEMPERATURE VALUES ARE RELATED



UNITS OF MEASUREMENT: Although the theoretical point at which all molecular motion ceases (absolute zero) does not exist, it is the lowest point on any temperature scale. The four common scales used are: (1) Fahrenheit, (2) Centigrade, (3) Kelvin, and (4) Rankine. Their relationships are shown below.

In 1927 a standardized temperature scale was adopted internationally, using accepted melting and boiling points as reference. These points are:

Point	°C
Boiling — Liquid Oxygen	−182.97
Melting — Ice	0.000
Boiling — Water	100.00
Boiling — Sulfur	444.60
Melting — Silver	960.8
Melting — Gold	1063

From −190 to +660° C, measure of temperature is based upon the indications of a standard platinum resistance thermometer. From +660° C to melting point of gold, a platinum-platinrhodium thermocouple is the reference instrument; above the gold point it is a monochromatic optical pyrometer.

Although a platinum resistance thermometer is accurate down to −263°C, there is no standard method for lower temperature measurement. However, one commonly used method is to measure the magnetic susceptibility of certain crystalline salts.

Like pressure, temperature has no definite upper limit. It ranges from unobtainable absolute zero to 6000° C at the surface and 40,000° C in the interior of the sun. The greatest temperature on the surface of the earth has been the estimated millions of degrees occurring in thermonuclear explosions.

For More Data, Turn the Page . . .

Petroleum Processing's Clip·n·File ENGINEERING DATA SHEET NO. 2

Two-Way Temperature Conversion Table

HOW TO USE IT:

To convert a temperature from °C. to °F. — locate your Centigrade temperature in the center column (in red), and read the corresponding Fahrenheit value in the column to the left.

To convert a temperature from °F. to °C. — locate your Fahrenheit temperature in the center column (in red), and read the corresponding Centigrade value in the column to the right.

°F. ← °C.		°F. → °C.	°F. ← °C.		°F. → °C.	°F. ← °C.		°F. → °C.	°F. ← °C.		°F. → °C.	°F. ← °C.		°F. → °C.
	−459.7	−273.2	− 0.4	− 18	− 27.8	194.0	90	32.2	388.4	198	92.2	986	530	276.7
	−450	−267.8	+ 3.2	− 16	− 26.7	197.6	92	33.3	392.0	200	93.3	1004	540	282.2
	−440	−262.2	6.8	− 14	− 25.6	201.2	94	34.4	395.6	202	94.4	1022	550	287.8
	−430	−256.7	10.4	− 12	− 24.4	204.8	96	35.6	399.2	204	95.6	1040	560	293.3
	−420	−251.1	14.0	− 10	− 23.3	208.4	98	36.7	402.8	206	96.7	1058	570	298.9
	−410	−245.6	17.6	− 8	− 22.2	212.0	100	37.8	406.4	208	97.8	1076	580	304.4
	−400	−240	21.2	− 6	− 21.1	215.6	102	38.9	410.0	210	98.9	1094	590	310.0
	−390	−234.4	24.8	− 4	− 20.0	219.2	104	40.0	413.6	212	100	1112	600	315.6
	−380	−228.9	28.4	− 2	− 18.9	222.8	106	41.1	417.2	214	101.1	1130	610	321.1
	−370	−223.3	32.0	0	− 17.8	226.4	108	42.2	420.8	216	102.2	1148	620	326.7
	−360	−217.8	35.6	+ 2	− 16.7	230.0	110	43.3	424.4	218	103.3	1166	630	332.2
	−350	−212.2	39.2	4	− 15.6	233.6	112	44.4	428	220	104.4	1184	640	337.8
	−340	−206.7	42.8	6	− 14.4	237.2	114	45.6	431.6	222	105.6	1202	650	343.3
	−330	−201.1	46.4	8	− 13.3	240.8	116	46.7	435.2	224	106.7	1220	660	348.9
	−320	−195.6	50.0	10	− 12.2	244.4	118	47.8	438.8	226	107.8	1238	670	354.4
	−310	−190	53.6	12	− 11.1	248.0	120	48.9	442.4	228	108.9	1256	680	360.0
	−300	−184.3	57.2	14	− 10.0	251.6	122	50.0	446	230	110	1274	690	365.6
	−290	−178.9	60.8	16	− 8.9	255.2	124	51.1	449.6	232	111.1	1292	700	371.1
	−280	−173.3	64.4	18	− 7.8	258.8	126	52.2	453.2	234	112.2	1310	710	376.7
−459.7	−273.2	−169.6	68.0	20	− 6.7	262.4	128	53.3	456.8	236	113.3	1328	720	382.2
−454	−270	−167.8	71.6	22	− 5.6	266.0	130	54.4	460.4	238	114.4	1346	730	387.8
−436	−260	−162.2	75.2	24	− 4.4	269.6	132	55.6	464	240	115.6	1364	740	393.3
−418	−250	−156.7	78.8	26	− 3.3	273.2	134	56.7	467.6	242	116.7	1382	750	398.9
−400	−240	−151.1	82.4	28	− 2.2	276.8	136	57.8	471.2	244	117.8	1400	760	404.4
−382	−230	−145.6	86.0	30	− 1.1	280.4	138	58.9	474.8	246	118.9	1418	770	410.0
−364	−220	−140	89.6	32	0	284.0	140	60.0	478.4	248	120.0	1436	780	415.6
−346	−210	−134.4	93.2	34	+ 1.1	287.6	142	61.1	482.0	250	121.1	1454	790	421.1
−328	−200	−128.9	96.8	36	2.2	291.2	144	62.2	500	260	126.7	1472	800	426.8
−310	−190	−123.3	100.4	38	3.3	294.8	146	63.3	518	270	132.2	1490	810	432.2
−292	−180	−117.8	104.0	40	4.4	298.4	148	64.4	536	280	137.8	1508	820	437.8
−274	−170	−112.2	107.6	42	5.6	302.0	150	65.6	554	290	143.3	1526	830	443.3
−256	−160	−106.7	111.2	44	6.7	305.6	152	66.7	572	300	148.9	1544	840	448.9
−238	−150	−101.1	114.8	46	7.8	309.2	154	67.8	590	310	154.4	1562	850	454.4
−220	−140	− 95.6	118.4	48	8.9	312.8	156	68.9	608	320	160.0	1580	860	460.0
−202	−130	− 90.0	122.0	50	10.0	316.4	158	70.0	626	330	165.6	1598	870	465.6
−184	−120	− 84.4	125.6	52	11.1	320.0	160	71.1	644	340	171.1	1616	880	471.1
−166	−110	− 78.9	129.2	54	12.2	323.6	162	72.2	662	350	176.7	1634	890	476.7
−148	−100	− 73.3	132.8	56	13.3	327.2	164	73.3	680	360	182.2	1652	900	482.2
−130	− 90	− 67.8	136.4	58	14.4	330.8	166	74.4	698	370	187.8	1670	910	487.8
−112	− 80	− 62.2	140.0	60	15.6	334.4	168	75.6	716	380	193.3	1688	920	493.3
− 94.0	− 70	− 56.7	143.6	62	16.7	338.0	170	76.7	734	390	198.9	1706	930	498.9
− 76	− 60	− 51.1	147.2	64	17.8	341.6	172	77.8	752	400	204.4	1724	940	504.4
− 58	− 50	− 45.6	150.8	66	18.9	345.2	174	78.9	770	410	210.0	1742	950	510.0
− 40	− 40	− 40.0	154.4	68	20.0	348.8	176	80.0	788	420	215.6	1760	960	515.6
− 36.4	− 38	− 38.9	158.0	70	21.1	352.4	178	81.1	806	430	221.1	1778	970	521.1
− 32.8	− 36	− 37.8	161.6	72	22.2	356	180	82.2	824	440	226.7	1796	980	526.7
− 29.2	− 34	− 36.7	165.2	74	23.3	359.6	182	83.3	842	450	232.2	1814	990	532.2
− 25.6	− 32	− 35.6	168.8	76	24.4	363.2	184	84.4	860	460	237.8	1832	1000	537.7
− 22.0	− 30	− 34.4	172.4	78	25.6	366.8	186	85.6	878	470	243.3	1922	1050	565.6
− 18.4	− 28	− 33.3	176.0	80	26.7	370.4	188	86.7	896	480	248.9	2012	1100	593.3
− 14.8	− 26	− 32.2	179.6	82	27.8	374	190	87.8	914	490	254.4	2102	1150	621.1
− 11.2	− 24	− 31.1	183.2	84	28.9	377.6	192	88.9	932	500	260.0	2192	1200	648.9
− 7.6	− 22	− 30.0	186.8	86	30.0	381.2	194	90.0	950	510	265.6	2282	1250	676.7
− 4.0	− 20	− 28.9	190.4	88	31.1	384.8	196	91.1	968	520	271.1	2372	1300	704.4

PERSONALS

Bill Wadt, formerly superintendent of Esso Standard Oil Co.'s Bayonne refinery, has been appointed assistant to the president of the Enjay Co., E. V. Tracy.

Wadt has spent most of his career at Bayonne, where he began in 1933 after taking his M.S. degree from M.I.T.

Bernard M. Sturgis, assistant director of the Du Pont Co.'s petroleum laboratory, has been given this year's Horning Memorial Award by the Society of Automotive Engineers. He was honored for authorship of a paper, "Some Concepts of Knock and Anti-Knock Action," which he presented at the SAE West Coast meeting in 1954. The paper was judged the best new contribution in the art of mutual fuel and engine adaptation that was presented at an SAE meeting during that year.

Dr. Sturgis

L. R. Goldsmith, whose promotion to general manager of technical departments for Shell Oil Co. was announced in last month's issue of PETROLEUM PROCESSING, formerly was manager of manufacturing.

He began with Shell in 1932 at Martinez, Calif., refinery, after his graduation with a B.S. in petroleum engineering from the University of California. He served with the Petroleum Administration for War for two years during World War II, and in 1946 became superintendent at the Wilmington refinery.

Goldsmith was appointed to the staff of the economic development department in New York in 1949 and became manager of the technological department in 1951.

J. B. Wyman, who has been appointed superintendent at Anacortes, was assistant manager of Shell's New York manufacturing operations department. He joined Shell in 1928 at the Wood River refinery. He rose in the refinery, becoming assistant superintendent there in 1941. In 1949 he took the same post at the Houston refinery. Wyman was moved to New York in 1955.

At the Wilmington refinery, **Clarence G. Petersen** has been made assistant superintendent, moving from manager of dispatching. He succeeds **R. H. Tubman,** who is being transferred to Shell's New York office. **Max F. Smith** has become manager of dispatching, giving his former job of thermal cracking department manager to **Clarence S. Bennett.** Bennett moves up from assistant manager of catalytic cracking, and **M. F. Smith** takes this post.

John A. Sherred, director of research development for Monsanto Chemical Co.'s plastics division, has been named director of development of the Lion Oil Co. Division of Monsanto.

Frank L. Emert, who has been assistant manager of Lion's El Dorado refinery, has been made director of engineering in the division. Sherred and Emert have taken over new posts in Lion's manufacturing department.

H. Harold Bible, formerly assistant manager of manufacturing, has been named director of manufacturing.

Sherred is from Leeds, England, and received his master's degree in chemistry from Oxford University's Balliol College in 1939. After several years with the Shell group of oil companies, he joined Monsanto in 1947 at the Texas City plant. In 1952 he was put in charge of development activities.

Emert has been with Lion Oil since 1940. After eight years at the El Dorado refinery he was transferred to the El Dorado chemical plant and became chief engineer there. Early in 1955 he returned to the refinery as assistant manager. He holds a B.S. degree in petroleum engineering from the University of Oklahoma.

Bible, also a graduate of the University of Oklahoma, has a B.S. in chemical engineering. He joined Lion in 1942 as synthesis supervisor at the Ozark ordnance works, located at El Dorado. He has been technical assistant to the vice-president of manufacturing, technical assistant to the president, and became assistant manager of manufacturing in 1952.

J. W. Leonard has been named chairman of the board of Leonard Refineries, Inc., at the firm's first board meeting since the merger of Leonard Mid-West Refineries, Roosevelt Oil & Refining Corp., and Leonard Pipeline Co.

Reid Brazell became president and chief executive officer. Vice-presidents named were: **E. Allan Morrow, L. R. Kamperman,** of marketing, **John S. Pfarr,** of manufacturing, and **R. J. Oosdyke,** of the mid-west division. **R. L. Anthony** was made secretary-treasurer and controller.

The executive committee is composed of Leonard, who is its chairman, Brazell, Morrow, and **Otto A. Seyfreth.**

Lucien O. Crockett has become a vice-president of Gulf Oil Co. He will continue to direct the chemical department, of which he had been general manager since April, 1955. He is also on the board of directors and on the executive committee of Goodrich-Gulf Chemicals.

Crockett began with Gulf in 1922 as laboratory assistant at the Port Arthur refinery. In 1934 he was named chief chemist for the three Gulf refineries then operated in Texas.

In 1945 Crockett was promoted to assistant general superintendent of the Texas refineries, and he was transferred to the general offices in Pittsburgh in 1950. He served as manager of the technical division of the manufacturing department, then manager of petrochemical activities until the company formed a chemical department and made him general manager.

Mr. Mangelsdorf

Mr. Warner

Harold G. Mangelsdorf has joined the executive committee of Esso Standard Oil Co., relinquishing his post of general manager of manufacturing to **J. Prince Warner.**

Mangelsdorf became a member of the Esso board in 1954 and continued to serve in the top manufacturing position, a post he was given late in 1953. He is a former general manager of Esso's East Coast Manufacturing Division.

Warner for the last year has been general superintendent of Esso's Baltimore refinery. **H. G. McBurney** has returned from special assignments in marketing and manufacturing to assume Warner's post at Baltimore.

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Massachusetts Institute of Technology, where he received his master's degree, Warner joined Essa as a research engineer at Baton Rouge in 1929. He headed the plant's technical division and its chemical products division before he became general superintendent in 1952. A year later he was named assistant general manager of Esso's Louisiana Division, and then moved in 1955 to the position at Baltimore.

William M. Murray, vice-president in charge of sales of Deep Rock Oil Co., is the new president of the National Lubricating Grease Institute.

Bernard C. Barton has been appointed director of research and development for the Texas-U.S. Chemical Co. He was formerly head of the rubber applications and synthetic rubber research department of the general laboratories of the U.S. Rubber Co. He will direct the company's efforts to produce improved synthetic rubbers and to expand the use of petrochemicals. His headquarters are in New York.

Mr. Barton

Barton received his B.A. degree from Wabash College and his Ph.D., in 1939, from Brown University. His primary interests since then have been in the development and use of synthetic rubbers and in the basic study of vulcanization and aging of elastomers.

Dr. R. K. Gould of The Texas Co. has been appointer editor of *Lubrication Engineering*, the journal of the American Society of Lubrication Engineers.

He has been with Texaco since 1941 and is currently engaged in technical service activities on industrial lubricants. He also serves as editor of the company's magazine *Lubrication*. Gould holds A.B., M.A. and Ph.D. degrees from Duke University.

L. F. Dowding has been appointed assistant general manager of Jefferson Chemical Co.'s manufacturing division. Dowding received an M.S. degree from M.I.T. in 1939. He was with The Texas Co. from then until 1949, rising to senior engineer in the company. He then transferred to Jefferson and worked in the engineering department at New York until 1954, when he was transferred to the Austin Laboratories as assistant director.

T. R. Miller has been appointed director of development for Carbide and Carbon Chemicals Co. He was formerly director of plant laboratories. Miller joined the company in 1940 after taking his Ph.D. degree in chemistry the same year from the University of Pennsylvania.

George H. Fremon has been made patent coordinator for the company. He has been with Carbide's technical staff since 1937, when he received a Ch.E. degree from Columbia University. His recent work has been on the development of new synthetic acrylic fibers. His headquarters are in the New York offices of the company.

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Ethylene

Ethylene, pronounced "**eth**-ih-lean," is currently the intermediate for more petrochemicals than any other single petroleum derivative. While it was originally chiefly available as a by-product from cracked refinery gases, it has long been a petrochemical in its own right. Ethylene is now being produced in large quantities (billions of pounds per year) by the deliberate cracking of a host of petroleum and natural gas materials—chiefly ethane and propane—but now also including butane, naphthas, and even gas oils and residuals. Commercial LPG, natural gasoline, and crude-oil distillate fractions are also possible feedstocks.

Ethylene has the formula $CH_2{=}CH_2$, a structure which reveals why so many chemicals can be obtained from it by addition (it has an unsaturated double bond), replacement of the hydrogen (H) radicals, polymeriza-

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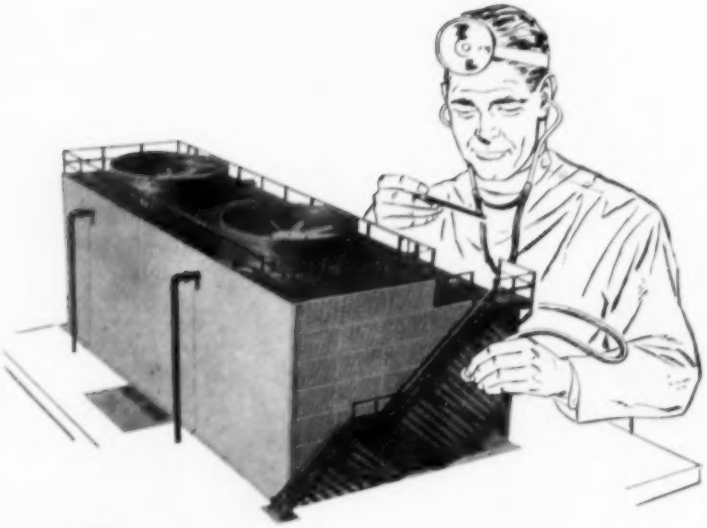

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The Marley Company

Kansas City, Missouri

tion (interaction of molecular units), etc. It is a colorless, flammable gas, only slightly lighter than air, and liquefies and solidifies at temperatures far below the freezing point of water.

While the uses of ethylene are legion, chief among them at present is the production of ethyl alcohol, ethylene oxide, polyethylene, styrene, ethyl chloride, ethylene dichloride, and ethylene dibromide. Minor direct uses of ethylene include the coloring of fruit, blanching of vegetables, and oxyethylene welding and cutting of metals.

Expansion of demand for many of its derivatives will continue to call for increased production of ethylene. This basic petrochemical faces a future as interesting and diverse as its past.

Polyethylene

Polyethylene, pronounced "**pahl**-ih-**eth**-ih-lean," is a versatile petrochemical plastic which is expected to approach the billion-pounds-per-year class soon after 1960. Tough, off-white in color, translucent (virtually transparent in thin sheets), and leathery (flexible even at low temperatures), this plastic material has exceptional electrical characteristics, is impermeable to water, and is generally resistant to organic solvents and chemicals.

Chief uses for polyethylene are packagings, (films and sheets), coatings, moldings, bottles and tubes (polyethylene has sometimes been called the "squeeze-bottle plastic"), pipe, and electrical applications (wire insulation, fixtures, etc.). While all these applications are expected to grow in scale, the greatest increases are anticipated for packagings (the field of largest preesnt use), tubes, and bottles.

Until recently, polyethylene was produced almost exclusively by the high-pressure polymerization (interlinking of molecular units into long chains) of ethylene ($CH_2{=}CH_2$), i.e., $-CH_2-CH_2-CH_2-CH_2-$. Recently, however, several low-pressure processes have been announced, and plants to use them are currently under construcion.

For a plastic less than 15 years old (commercially), polyethylene has already come into considerable prominence, and even greater things are expected. That is why plant construction is proceeding at such a rapid pace that consumption may not catch up with plant capacity for three or four years.

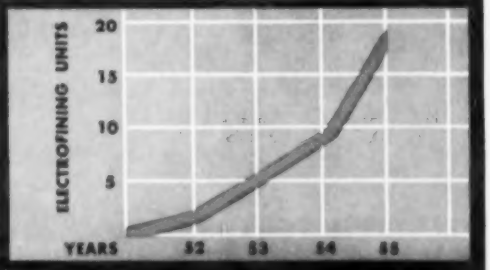
 (To obtain more data on advertised products see page 122)

WHY THE ACCELERATING INTEREST IN

ELECTROFINING

In 1950 the first Petreco Electrofining* Unit was installed. Now there are 18 Electrofiners installed and — at the last count — six more under construction and on order.

**Petreco Electrofining is a compact, automatic, fast treating process for continuously contacting a light hydrocarbon stream with a treating agent, then rapidly separating the chemical from the treated product.*



THIS TABLE SHOWS THE WIDE ACCEPTANCE AND APPLICABILITY OF *ELECTROFINING*.

ELECTROFINING INSTALLATIONS

Refinery Location	Electrofining Treatment	Number of Units	BPD Capacity	Stock Treated
California	Acid	1	16,000	Light Pressure Distillate
California	Acid	4	8,600	Lube and Spray Oils
Indiana	Caustic	1	10,000	Blended light cycle oil and straight run naphtha
Kansas	Doctor	1	11,000	Straight run and cracked gasoline
Pennsylvania	Caustic**	1	12,500	Gasoline
Pennsylvania	Caustic**	1	3,600	Gasoline
Texas	Caustic**	2	5,000	Thermally cracked distillate
Texas	Caustic**	2	5,000	Cat distillate
Texas	Caustic**	3	30,000	Cat distillate
Texas	Acid	1	4,430	Lube Oil
Texas	Sulfonation	1	2,000	Virgin distillate
Texas	Dewatering	2	6,000	Vacuum Tower Gas Oil

**Caustic Scrub and Water Wash

Additional Electrofiners are under construction or on order for refiners in Canada, Pennsylvania, New York, Ohio, and New Jersey.

HERE ARE THE REASONS WHY MORE AND MORE REFINERS ARE SPECIFYING ELECTROFINING FOR LIGHT OIL TREATING:

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6. Eliminates Haze Stabilizers
7. Fast-Tower to Market
8. Efficient—Removes Tarry Acids, Spent Caustic, Metals, Mercaptans and other Impurities
9. Flexible—Single, Dual, Two Phase Units Available
10. Automatic—Minimum Operating Attention Required
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Unsuspected copper may be causing your gasoline to form GUM

When your gasoline leaves the refinery, it may not contain a trace of copper . . .

But pump-island surveys show that most gasolines pick up some copper before they reach your customers' car tanks. And copper in concentrations of less than one part per million can catalyze the gum-forming reactions to a harmful level. One Du Pont gasoline quality survey, for example, disclosed significant amounts of copper present in 91% of 241 gasoline samples from representative service stations in the U.S. and Canada. And the gasolines known to contain no metal deactivator were found to be high in gum content.

The results of this survey indicate clearly that, in spite of the great pains taken to prevent copper contamination during refinery operation, copper is getting into the majority of gasolines sold. How? . . . Probably from contact with valves, pumps and other sources in the distribution system.

You CAN control it

Only about 1 pound of Du Pont Metal Deactivator (DMD) per 1000 barrels is needed to safeguard your gasolines against the harmful effects of copper. And in this low concentration, it costs you less than ½ of a cent per barrel to get this effective and important quality insurance.

DU PONT METAL DEACTIVATOR also has valuable applications in kerosines, jet and diesel fuels, furnace and turbine oils.

Ask for a sample and prove to yourself its effectiveness. Or ask one of our regional laboratories to evalute it for you, in your own stocks. Just address your request for this service to the nearest sales office listed below.

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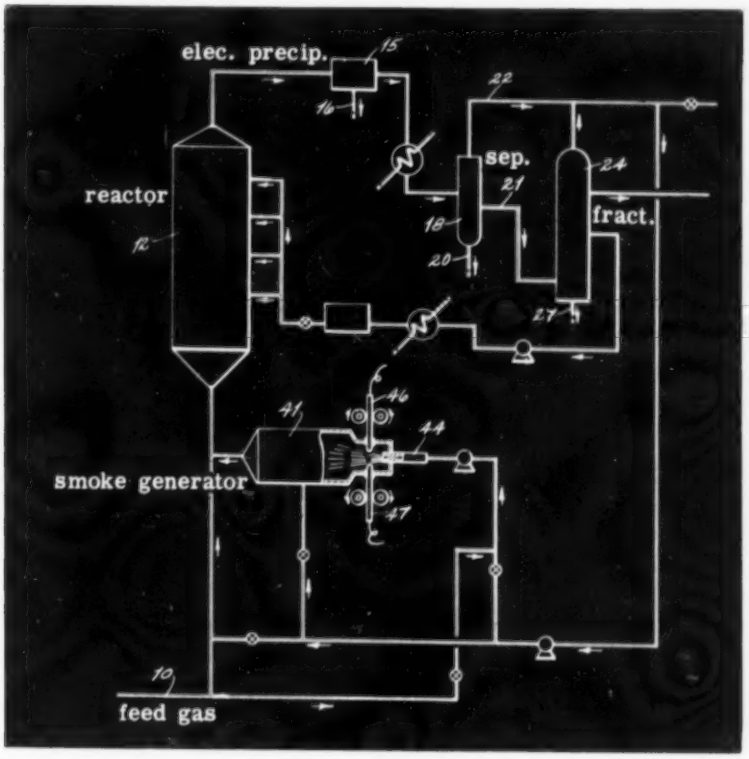
By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.



HYDROCARBON SYNTHESIS using a smoke catalyst. See text for details

Use Smoke Catalyst in Synthesis To Lower Catalyst Consumption

HYDROCARBON synthesis from carbon monoxide and hydrogen is claimed to be more effectively carried out by use of a solid catalyst having a particle size of about 0.1 to 0.5 micron, or finer—that is, having a particle size of the order of smoke particles which remain in suspension in the moving gaseous atmosphere. Such particle size is in a range too small to permit fluidization or fixed-bed contact.

In U. S. Patent No. 2,714,116, Texaco Development Corp. points out that a major advantage of such a system is the reduced overall consumption of catalyst in a continuous operating process. For example, a typical fluid hydrocarbon synthesis process using a fluidized, solid particle iron catalyst and charging about 240 million cu.ft./day of synthesis gas, will consume about 6 tons of make-up catalyst per operating day. This means a running consumption of about one pound of catalyst per 20,000 cu. ft. of charge gas under settled operation, neglecting the substantial catalyst losses owing to the discharge of the reactor's contents at the termination of an operating run. On the other hand, use of a smoke catalyst is claimed to involve a catalyst consumption of not over one pound per 30,000 cu. ft. of charge gas, and may be substantially less.

The system employed is outlined schematically in the illustration. The feed gas entering through pipe 10 is passed as a jet from nozzle 44, which is between two catalyst electrodes 46 and 47. The projection rates of the gas jet should approach the speed of sound, i.e., over 300 meters per second. The smoke thus formed is passed from generator 41 to reactor 12, where substantial conversion of the gases to hydrocarbons takes place.

The synthesis gas used has an H_2:CO ratio of from 1.5:1 to 2.2:1. The reaction zone is maintained at about 650° F. With a smoke phase composed essentially of particles of less than one micron, some 20,000 to 30,000 std. cu. ft. of synthesis gas are said to be convertible into hydrocarbons, predominantly boiling in a normally liquid boiling range, per pound of iron consumed at electrodes 46 and 47. Preferred pressures are 150-550 psi.

The reaction gases then are passed through electrical precipitator 15 for removal of catalyst through discard line 16. Then through separator 18 for removal (by pipe 20) of aqueous condensate. Gas leaves through overhead line 22. The oil phase is passed through line 21 into fractionator 24, and gasoline is drawn off at side line 25, while heavier oils are removed as bottoms through pipe 27.

New Process for Synthesis Of Hydrocarbon Polymers

THE Arnold and Carnahan patent No. 2,572,300 described new catalytic compositions having a relatively large surface area per unit of mass. They consist of molybdites of metals whose ions form soluble compounds in excess aqueous ammonia, for instance Zn, Cu, Ni, Co. Du Pont workers have found that these new catalysts provide a good method for producing high molecular weight hydrocarbons from carbon monoxide and water.

In U. S. Patent No. 2,714,583, Du Pont describes the synthesis of polymethylenes without introduction of hydrogen from an external source. The polymethylenes produced are solid under normal conditions. They can be oriented on cold drawing and spun into fibers, thus providing a new method for obtaining hydrocarbons of high molecular weight.

The mol ratio of CO to water is generally at least 3:1. The process is carried out by charging a pressure reactor with water and catalyst, sweeping with oxygen-free nitrogen, cooling to 0° C., and evacuating. Thereafter, carbon monoxide is injected to build up the reactor pressure so that at a temperature between 125° C. and 350° C. the total pressure is at least 200 atm. Then the charge is agitated. When pressure drop ceases, the reaction may be stopped or additional

CO pressure added to maintain reaction conditions.

In one experiment, the reaction was carried out in a silver-lined shaker tube, using nickel molybdite (Ni Mo O_2) catalyst. This yielded a white hydrocarbon polymer of the general formula $(CH_2)n$, with a melting point 124-130° C. and relative viscosity of 1.101. It was manually spun to give fibers, and also gave flexible films having a tensile strength of 4035 psi.

Patents Issued Recently

The following classified listing gives the patent number, patentee, or assignee, and a description of all patents of interest to the petroleum processing industry in the Official Gazette of the U. S. Patent Office for Nov. 29, Dec. 6 and 13, 1955, Vol. 700, No. 5 and Vol. 701, No. 1 and 2.

PROCESSES

Refining

2,725,337 (Black, Sivalls & Bryson, Inc.) Method and apparatus for low temperature separation and stabilization of liquid hydrocarbons from high-pressure natural gas.

2,725,338 (Esso Research & Engineering Co.) Wax crystallization process and apparatus, using reciprocating pulsations.

2,725,339 (Socony Mobil Oil Co.) Solid caustic treatment of hydrocarbons, using particles of 40 micron diameter.

2,725,340 (Standard Oil Co. Ind.) Clarification of oils, using caustic and air blowing.

2,725,342 (The Lummus Co.) Distillation (topping crude oil).

2,725,343 (The Lummus Co.) Vapor-liquid contact apparatus (vacuum distillation column).

2,725,351 (Universal Oil Products Co.) Fractionation control system.

2,725,986 (Bowser, Inc.) Water-fuel separator.

2,726,145 (British Petroleum Co.) Liquid mixture countercurrent extraction apparatus.

2,726,191 (Continental Oil Co.) Processing raw natural gas to recover gaseous and gasoline hydrocarbons, by use of lean absorber oil.

2,726,193 (British Petroleum Co.) Catalytic desulfurization of petroleum hydrocarbons in presence of hydrogen.

2,726,194 (Shell Development Co.) Removing gum-forming components from hydrocarbon distillates by heating in presence of oxygen and removing peroxides without affecting alkadienes.

2,726,198 (Shell Development Co.) Flash vaporizing method and apparatus.

2,726,261 (Sinclair Refining Co.) Process for producing concentrates of sulfonic acids in petroleum oils.

2,726,932 (Standard Oil Co. Ind.) Processing dilute H_2S streams containing chiefly HF, using free oxygen.

2,726,933 (Allied Chemical & Dye Corp.) Production of sulfur from H_2S.

2,726,986 (Texaco Development Corp.) Refining of lubricating oil solvent extracts with silica gel.

2,726,987 (Esso Research & Engineering Co.) Solvent dewaxing of lubricating oil by forming nucleating ice crystals.

2,726,988 (Esso Research & Engineering Co.) Solvent dewaxing process, using ketone and water.

2,726,989 (Standard Oil Co. Ind.) Heater oil purification using sulfur dioxide and a halogen.

2,726,990 (Sun Oil Co.) Separation of oil and wax.

2,726,991 (Standard Oil Co. Ind.) Hydrocarbon desulfurization process with calcined reaction product of titanium halide and phosphoric acid.

2,726,992 (California Research Corp.) Process for removing carbonyl sulfide from liquefied petroleum gases, using diethanolamine.

2,726,993 (Esso Research & Engineering Co.) Process for improving liquid fuel oils by treating with propanol and a metal passivator salt.

2,726,996 (Phillips Petroleum Co.) Conversion of heavy oils by means of hot pebbles along a spiral path.

2,726,997 (Esso Research & Engineering Co.) Clay contacting process.

2,726,999 (American Oil Co.) Use of phenol to prevent fouling during extractive distillation of benzene concentrates.

Conversions

2,725,341 (Esso Research & Engineering Co.) Fluid hydroforming of naphthas.

2,725,344 (Esso Research & Engineering Co.) Upgrading of naphthas to form olefins and epoxides by non-catalytic oxidation.

2,725,347 (Universal Oil Products Co.) Process and apparatus for distilling solid carbonaceous materials.

2,725,348 (Esso Research & Engineering Co.) Fluidized distillation of oil-bearing minerals.

2,725,349 (Esso Research & Engineering Co.) Fluid coking with alumina seeds.

2,726,121 (Houdry Process Corp.) Apparatus for pneumatic elevation of granular solids.

2,726,122 (Socony Mobil Oil Co.) Method for pneumatic transfer of granular contact material in a moving-bed conversion process, and apparatus therefor.

2,726,135 (Gulf Oil Corp.) Valve and process for transfer of solid particles.

2,726,136.7 (Gulf Oil Corp.) Solid particle transfer process and apparatus.

2,726,146 (Houdry Process Corp.) Gas solid contacting and separation tower.

2,726,195 (Union Oil Co. of Calif.) Catalytic process for hydroforming in presence of phosphate of element of atomic weight 22-42.

2,726,196 (Lummus Co.) Gilsonite conversion.

2,726,197 (Shell Development Co.) Catalytic cracking system, using finely divided catalyst in fluidized bed.

2,726,938 (Sun Oil Co.) Apparatus for supplying contact material to a reaction chamber.

2,726,994 (Socony Mobil Oil Co.) Method of conserving recycle gas, using reforming.

2,726,995 (Universal Oil Products Co.) Method for contacting and transporting subdivided contacting material.

2,726,998 (Phillips Petroleum Co.) Process and apparatus for shale oil extraction.

2,727,024 (Standard Oil Co. Ind.) Group 5A metal oxide and alkali metal aluminum hydride catalyst for olefin polymerization.

2,727,077 (American Oil Co.) Production of benzene from virgin naphtha.

Hydrocarbon Synthesis

2,725,285 (The Texas Co.) Engine generation of synthesis gas.

2,726,218 (Du Pont Co.) Hydrogenation of carbon monoxide to hydrocarbons with tungstite catalyst.

2,727,055 (Standard Oil Co. Ind.) Catalytic synthesis of aromatic hydrocarbons from CO and H_2, using alumina catalyst.

2,727,056 (Metallgesellschaft A.G.) Process for hydrocarbon synthesis with a precipitated iron catalyst containing an alkali oxide and precipitated silicic acid.

PRODUCTS

Chemicals

2,725,374 (Standard Oil Co. Ind.) Polymerization of ethylene with alkali metal and group 6A metal oxide.

2,725,396 (American Colloid Corp.) Process for the oxidation of white mineral oils to dicarboxylic naphthenic acids.

2,725,400 (Shell Development Co.) Method for producing ketones from secondary alcohols.

2,725,401 (Esso Research & Engineering Co.) Synthesis of oxygenated organic compounds, particularly aldehydes, from CO, hydrogen and olefins.

2,725,403 (Imperial Chemical Industries Ltd.) Hydration of olefins, using oxide of tungsten as catalyst.

2,725,404 (Ethyl Corp.) Dehydrochlorination of benzene hexachloride.

2,725,406 (Ethyl Corp.) Dehydrochlorination.

2,725,407 (Ethyl Corp.) Concentration of 1,2,4-trichlorobenzene.

2,725,408 (Ethyl Corp.) Recovery of trichlorobenzene.

2,725,412 (Ethyl Corp.) Chlorination of 1,1-dichloroethane.

2,725,413 (Standard Oil Co. Ind.) Ethyltoluene production from ethylbenzene and toluene.

2,726,192 (Atlantic Refining Co.) Extraction and fractionation of petroleum resins with N-butanol.

2,726,198 (Esso Research & Engineering Co.) Hydrodesulfurization of oxo alcohols.

2,726,204 (Monsanto Chemical Co.) Emulsion polymerization process under electrical potential.

2,726,228 (Universal Oil Products Co.) Resins prepared from unsaturated ketones.

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This position will require extensive experience with very complex fluid flow problems, such as are encountered in the following types of equipment: distillation, dust collecting, filtration, grinding, drying, materials handling, absorption-extraction, and agitation and mixing. Successful applicant will develop specialized equipment such as jet reactors, jet compressors, jet absorbers, and pipe line reactors, and provide technical advice on fluid flow problems involved in handling slurries, plastics, highly viscous polymers, dispersion, and semi-solids.

CONTROL SYSTEMS MAINTENANCE

Successful applicant will have had extensive experience in the installation, application, and maintenance of chemical process instrumentation. Duties include: setting up or modernizing plant maintenance forces for proper care of electronic, pneumatic, and hydraulic controls and instrumentation; making cost studies; planning and organizing training programs for maintenance personnel; instituting effective preventive maintenance programs; development of standard procedures for instrument calibration and maintenance; and assistance in establishing efficient installation methods and in start-up of new facilities.

HEAT TRANSFER

Duties include: trouble-shooting on equipment, such as pipe line reactors, fluidized solids reactors, and film driers, where heat transfer is one controlling factor; selection of equipment to determine optimum alternatives; and theoretical analysis of problems in heat transfer in proposed equipment for new applications. Other typical heat transfer problems encountered involve reboilers, inert gas generators, direct fired production furnaces, and indirect fired retorts.

PUMPS AND FLUID MECHANICS

Desired qualifications will include extensive engineering knowledge of and familiarity with equipment used in the fluid mechanics field. Development, research, design, maintenance, or teaching experience with pumps, compressors, jets, and seals is desirable. Responsibilities of the position will involve selection of equipment and recommendations for equipment modification for special applications.

AUTOMATIC PROCESS CONTROL

Position requires broad and detailed experience in research, application, consulting, or design of automatic controls for chemical, mechanical, or aeronautical applications. The successful applicant will provide consulting advice to operating plants and development laboratories on the application of automatic control to new processes and for the improvement of existing processes. Position will require the study of controllability by analysis of open and closed loops and the measurement of control characteristics of instrument components.

PETROCHEMICAL PROCESS & EQUIPMENT

Successful applicant will analyze existing and proposed chemical processes for utilization of petroleum processing equipment and methods for obtaining greater yield and lower equipment investment, particularly with respect to hydrocarbon processes. Typical operations to be evaluated include solid fluidization, adsorption, reforming, and catalysis. This requires broad familiarity with equipment such as hypersorbers, distillation columns, cracking furnaces, low temperature refrigeration systems, and compressors. Other duties include trouble-shooting and economic evaluation of alternative processes and equipment.

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2,726,231 (Standard Oil Co. Ind.) Preparation of solid polymers from ethylene and the like in the presence of alkali metal hydrides and group 6A metal oxide catalysts.

2,726,234 (Standard Oil Co. Ind.) Conversion of gaseous olefins to solid polymers with group 6A metal oxides and alkaline earth metals.

2,726,255 (Monsanto Chemical Co.) Oxidation process by treating acyclic alkanesenes with hydroperoxide.

2,726,268 (Esso Research & Engineering Co.) Synthesis of aldehydes by reacting olefins with CO, hydrogen, and Co carbonylation catalyst.

2,726,273-4 (Universal Oil Products Co.) Production of drying oils by reacting olefins with other compounds and HF.

2,726,275 (Standard Oil Co. Ind.) Separation of ethylbenzene from mixed C_8H_{10} aromatic hydrocarbons with AgF and HF.

2,726,276 (Union Oil Co. of Calif.) Acetylene-making process by partial oxidation of hydrocarbons.

2,726,734 (The Luminus Co.) Acetylene purification with selective solvent.

2,726,933 (Ethyl Corp.) Manufacture of chloramine.

2,727,911 (Standard Oil Co. Ind.) Hexamethylbenzene BF_3HF complex and solution thereof.

2,727,914 (Phillips Petroleum Co.) Method for retarding previdemization of rubber mixes.

2,727,922 (Standard Oil Co. Ind.) Process for polymerizing isoolefin polymers with isopentane diluent.

2,727,923 (Standard Oil Co. Ind.) Ethylene polymerization, using reduced Co and Ni catalyst.

2,727,935 (Standard Oil Co. Ind.) Urea adducts of polyol esters.

2,727,950 (Standard Oil Co. Ind.) Caustic oxidation of alcohols and aldehydes.

2,727,954 (California Research Corp.) Method of preparing silicate esters.

2,727,957 (Monsanto Chemical Co.) Preparation of ethylene sulfonates.

2,727,958 (Douglas Aircraft Co.) Completely halogenated phosphate esters and the method of making the same.

2,727,964 (British Celanese Ltd.) Production of acetic acid from methanol.

2,727,978 (Standard Oil Co. Ind.) Xylene concentration process.

Catalysts

2,725,360 (Esso Research & Engineering Co.) Preparation of activated carbon by forming carbon-sulfur complex.

2,726,216 (Esso Research & Engineering Co.) Process for the manufacture of silica hydrosols.

2,727,910 (Standard Oil Co. Ind.) Reactivation of titanium-phosphorus catalysts.

Fuels

2,725,933 (The Texas Co.) Gas burner apparatus for the generation of carbon monoxide and hydrogen.

2,726,148 (Gulf Research & Development Co.) Production of low sulfur solid carbonaceous fuels (desulfurizing coal without excessive conversion into gas or vapor).

2,726,942 (Standard Oil Co. Ind.) Motor fuels containing alcohol and hydroformer polymer.

2,727,952-3 (Ethyl Corp.) Manufacture of tetraethyllead.

Lubricants

2,725,345 (Esso Standard Societe Anonyme Francaise) Stabilized mineral oils, by adding propane deasphalted residual oil for oxidation resistance.

2,725,357 (The Texas Co.) Lubricating oils containing hydroxy and alkoxy-metal oxyarylalkyl amines.

2,725,358 (The Texas Co.) Lubricating oils containing hydroxy-metal oxyarylalkyl amines.

2,725,359 (Shell Development Co.) Lubricating oil composition containing phosphorus compound antioxidant.

2,725,744 (Industrial Rayon Corp.) Method and apparatus for lubricating knitting machines with plasticizer in prepluticized yarn.

2,726,208 (Standard Oil Co. Ind.) Non-corrosive lubricant composition containing oil soluble salt complex containing P-S.

2,726,209 (Standard Oil Co. Ind.) Extreme pressure lubricant with sulfur-containing lead talate, etc.

2,726,210 (Continental Oil Co.) Lubricants containing olefin-nitrosyl halide adduct, etc.

2,726,212 (Standard Oil Co. Ind.) Pour-point depressor purified by urea.

2,726,336 (Shell Development Co.) Production of sulfur-containing high molecular weight hydrocarbon derivatives as additives for lubricants.

2,727,905 (The Texas Co.) Marine engine lubricating oil containing a petroleum oxidate.

2,727,906 (Monsanto Chemical Co.) Foam-resisting hydrocarbon oils containing homo polymeric di-n-butyl itaconate.

2,727,910 (Standard Oil Co. Ind.) Method of sulfurizing unsaturated hydrocarbons with S_2Cl_2.

2,727,936 (Esso Research & Engineering Co.) Hydrocarbon oil additive (salt of heterocyclic compound).

2,727,967 (Lubrizol Corp.) Preparation of phosphinodithioic acid anhydrides by heating the corresponding acids.

2,727,973 (Lubrizol Corp.) Preparation of diaromatic trichlorophosphazanes by the chlorination of a phosphinodithioic acid or a phosphinothioic chloride.

Specialties

2,726,149 (Standard Oil Co. Ind.) Defoliation of plants with water-soluble solids.

2,726,213 (John B. Pierce Foundation) Hydraulic liquids having improved temperature-viscosity relationship, comprising cresyl triisopropyl oxilicate, etc.

2,726,215 (Atlantic Refining Co.) Rust inhibitors for aqueous systems, including salt of sebacic or azelaic acids.

2,726,980 (Phillips Petroleum Co.) Insect repellent amines produced by reacting 1, 3-butadiene and ammonia and method of using same.

Miscellaneous

2,726,009 (Plastic Products Corp.) Non-corrosive plastic tank for petroleum products.

EQUIPMENT

Processing, general

2,725,871 (Worthington Corp.) Heat exchanger utilizing products of combustion as a heating medium.

2,726,072 (Dynamit-A.G. vormals Alfred Nobel & Co.) Device for absorbing gases by liquids, especially for making hydrochloric acid.

2,726,135 (Gulf Oil Corp.) Valve and process for transfer of solid particles.

2,726,136-7 (Gulf Oil Corp.) Apparatus for solid particle transfer.

2,726,145 (British Petroleum Co. Ltd.) Countercurrent extraction apparatus.

2,726,197 (Shell Development Co.) Catalytic cracking system.

2,726,198 (Shell Development Co.) Flash vaporizing method and apparatus.

2,726,938 (Sun Oil Co.) Apparatus for supplying contact material to a reaction chamber.

2,726,998 (Phillips Petroleum Co.) Apparatus for shale oil extraction.

2,727,037 (Monsanto Chemical Co.) Device and process for preparing melamine.

Instruments

2,725,744 (Houston Oil Field Material Co.) Continuous viscosimeter.

2,725,748 (Taylor Instrument Co.) Composite thermometer.

2,725,844 (Albert Wittlin) Flow indicator.

2,726,546 (Robert W. King, Jr.) Flow measuring apparatus.

2,726,547 (Kelvin & Hughes Ltd.) Pressure indicator.

2,726,548 (Ruhrchemie A.G.) Gas sampler.

2,726,670 (Coleman Instruments) Flow control apparatus.

2,727,112 (Claude A. Davis) Liquid level control.

Valves & Fittings

Re 24,102 (Robert L. Olds) Valve assembly.

2,725,896 (Walker Crosweller) Valve.

2,725,989 (Melvin H. Standbury) Pipe guide and joint protector.

2,726,104 (Oil Center Tool Co.) Pipe joint swivel with fluid seal.

2,726,672 (Ohio Injector Co.) By-pass means for valves.

2,726,673 (Peters & Russell Inc.) Check valve.

2,726,840 (Shand and Jurs Co.) Valve construction.

2,726,842 (Lewis M. C. Seamark) Gate valves.

2,726,843 (General Electric Co.) High temperature valve seat.

Miscellaneous

2,726,006 (Goodyear Aircraft Corp.) Closure for high-pressure vessels.

2,726,009 (Plastic Products Corp.) Non-corrosive tank for petroleum products.

2,726,032 (General Electric Co.) Compressed, including unbonding head.

2,726,604 (Thompson Products) Mixed flow multiple pump.

2,726,681 (Brown Fintube Co.) Internally finned tube.

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(To obtain more data on advertised products see page 122)

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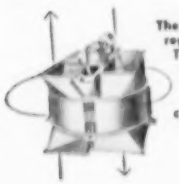

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The Air Preheater Corporation **60 East 42nd Street, New York 17, N. Y.**

Anderson Joins Dresser Board

Robert B. Anderson, former Secretary of the Navy and Deputy Secretary of Defense in the Eisenhower administration, has joined the board of directors and the executive committee of Dresser Industries, Inc. Mr. Anderson is also president of Ventures Ltd., a Canadian mining company.

Mr. Anderson

Prior to his government service he had a career in the oil business as attorney and general manager for the W. T. Waggoner estate, an oil bearing property in Vernon, Texas. Mr. Anderson began in politics at 22 as a member of the Texas legislature.

Hooker Names New Director

Robert E. Wilkin has been named to the board of directors of Hooker Electrochemical Co. and appointed vice-president and director of sales. He was formerly vice-president and general sales manager.

Mr. Wilkin's first job in industry was with Standard Oil Co. (Ind.) as a research chemist. In 1927 he was moved to the technical department of the sales division and later became manager of the department. He joined Hooker in 1936 as sales manager of fine chemicals. He became next assistant sales manager in 1939, eastern sales manager in 1943, general sales manager four years later, and added the title of vice-president in 1953.

U.S Steel to Boost Output

Expansion of ingot capacity in two areas is planned by the United States Steel Corp. The plant at Geneva, Ut., is currently being enlarged by 380,000 tons of capacity, an addition of 20%. And there are plans to increase the ingot capacity of facilities in the Chicago area by approximately 1,500,000 tons.

Further increases in capacity of the company's plants are foreseen in the next three years through changes and improvements in individual facilities. The over-all growth is expected to amount to about 2,500,000 tons of ingots. There will be a corresponding increase in the production of finished products at each location.

In the meantime, the company's U.S. Steel Supply Division has opened a new steel warehouse in Dallas at 157 Pittsburg St. Stocked will be carbon, alloy and stainless steels, plus specialty items such as high strength and dardalet rivet bolts, expanded metal and other products.

A. T. Schmitt is the company's sales representative in the warehouse office.

Graver Promotes Five

S. Earl Allen has been made general manager of all divisions of the Graver Tank & Manufacturing Co. Mr. Allen was formerly manager of operations at East Chicago. For 17 years he was president of his own company, which specialized in foundry and machine work. He was next with the American Locomotive Co. as foundry and machine consultant, and then with Pusey and Jomes of Wilmington, Del. Here he served as vice-president of manufacturing.

Graver's new manager of operations is Wayne W. McWhorter, who was manager of field erection for all the company's operations. He joined Graver in 1954. His past experience includes 13 years with the Koppers Co. and service with various major companies in the erection of new equipment.

Frank B. Albert has been made assistant to the manager of operations, coming from general superintendent of Graver's East Chicago plant. Prior to joining the company in 1939 he was with the United Boiler Heating and Foundry Co., Hammond, Ind., where he served for 20 years as general superintendent.

Leonard J. Cogan has been appointed manager of all Graver's sales, with the exception of the Mid-Continent Division, Graver Construction Co., and Graver Water Conditioning Co. He was formerly assistant manager of eastern sales.

Stanley B. Beecher has taken the post of plant manager of the East Chicago central division. He was previously manager of the field department. He has been with the company since 1917.

Foxboro School Expanding

The training program for instrument personnel will double in size at the Foxboro Co.'s training and education center in Foxboro, Mass. A new building, accommodating 46 trainees, will be completed early in 1956, and the number of courses offered almost doubled. This will cut the waiting time decisively for persons enrolled by their companies.

The courses will include specialized training in electronic instruments and advanced forums for various industry groups, as well as the standard three-week general program, which covers all phases of instrument work.

Norman A. Anderson and John B. Parkes, Jr., have been added to the training staff, which now includes five full-time instructors in instrumentation.

Knight Joins ChE Consultants

Graham B. Knight has joined Joseph R. Minevitch in the latter's practice of consulting chemical engineering in Boston. Mr. Knight has been connected in the past with E. B. Badger & Sons Co. and its successor, Badger Process Division of Stone and Webster Engineering Corp. His most recent connection was with Badger Manufacturing Co.

Mr. Knight

Mr. Knight is a registered engineer in Massachusetts, Texas, and New York, and has had extensive experience in process engineering and design.

ACS Names Division Chairman

Dr. Harlan W. Nelson, Battelle Memorial Institute, has been elected chairman of the American Chemical Society's Division of Gas and Fuel Chemistry. He succeeds Dr. Martin B. Neuworth, research supervisor of the Pittsburgh Consolidation Coal Co.

Dr. Nelson is chief of the division of fuels and combustion research at Battelle. He has been in fuel technology since his graduation with a Ph.D. from the University of Illinois in 1933. He began with Battelle in 1944 and was named division chief in 1951.

Personnel Changes

Cooper-Bessemer Corp.—Robert F. Lay to vice-president and general sales manager; David M. Salls to home office manager of the gas and oil industry sales engineering section.

Beckman Instruments, Inc.—William G. Newton to chief industrial engineer of the Beckman Division. He

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Write for Bulletin 3, 4 and 7.

The CLEVELAND
WIRE CLOTH & MFG. Co.
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was formerly with General Aniline & Film Corp.

Western Supply Co.—E. D. Anderson, formerly chief engineer, to manager of the heat exchanger division; E. W. Flaxbart, chief rating engineer, to chief engineer in the division.

Allied Chemical & Dye Corp.—Frank J. Kiernan to technical engineer of protective coatings sales for the Barret Division.

Gustin-Bacon Mfg. Co.—J. A. Fairfield to the Chicago sales district; R. E. Van Winkle to the sales force in Michigan, northern Indiana and northwestern Ohio, replacing J. E. Rapp, who has been transferred to the home office in Kansas City; C. Barry Neill, Jr., to the Atlanta sales area.

General Aniline & Film Corp.—Walter A. Hensel to vice-president. He continues as manager of the Ozalid Division.

Consolidated Electrodynamics Corp.—Samuel Gilman to technical assistant to the director of the systems division. He will work as a special consultant on electronic data-processing systems.

Clark Bros. Co.—Gordon Lefebvre, formerly president of Cooper-Bessemer Corp., has joined the company in an executive advisory capacity.

Bemis Bro. Bag Co.—Judson Bemis to the newly created post of executive vice-president; T. H. Ashton, manager of the Omaha plant and sales division, to succeed Mr. Bemis as director of central operations; C. W. Akin, assistant director of sales, to Mr. Ashton's post at Omaha; R. M. Hersey to sales director for national accounts, a new function in the firm; J. H. Eastman to succeed Mr. Hersey as manager of the Minneapolis general sales division; M. F. P. Dallison to special account executive in Minneapolis.

Procon, Inc.—Lawrence M. Griffin has joined the staff and will work on the Continent with the company's English affiliate. He was formerly with Southwestern Engineering Co.

International Nickel Co.—Edmund M. Wise to assistant to the vice-president and manager of the development and research division; Dr. George T. Paul to the corrosion engineering section of the division, where he will first prepare a book on the corrosion resistance of stainless steels; Emil G. Holmberg has also joined the corrosion engineering section.

Robertshaw-Fulton Controls Co.—T. H. Pierson to vice-president of Eggelhof Engineers, Inc., a Robertshaw-Fulton representative in Texas, Louisiana, and Oklahoma.

Branches, Distributors

Koch Engineering Co. has appointed Jacobs Engineering Co., Pasadena, Calif., representatives for the Pasadena area. Jacobs will handle the "Flexitray" and "Benturi" fractionating trays for refineries and chemical plants.

Petro-Chem Development Co. has named two sales agents for its line of "Iso-Flow" heaters. Faville-LeVally Corp., Chicago, will cover Illinois, Wisconsin, Michigan, northern Indiana, western Ohio and St. Louis, Mo.; G. M. Wallace Co., Denver, Colo., will serve Montana, Wyoming, Colorado, and most of New Mexico.

ALCO Products, Inc., has appointed Power Machinery Co. agents for its new "Alcotwin" line of finned tube heat exchangers. The company will be exclusive agents in Kansas, Oklahoma, Texas and Louisiana.

General Ultrasonics Co. has made MacDermid Sales and Equipment Corp., Bristol, Conn., engineering and sales representatives in Connecticut; Louis V. Gagnon will handle the same functions in Massachusetts, Rhode Island, New Hampshire, Vermont and Maine. His headquarters are at Framingham, Mass.

Stratford Engineering Corp. has appointed D. D. Foster Co. as sales representatives for western Pennsylvania, eastern Ohio, Boyd county in Kentucky, West Virginia, and Garret and Alleghany counties in Maryland.

Expansion, Transition

H. K. Porter Co. has changed the name of its Watson-Stillman Fittings Division to W-S Fittings Division. The division will retain its trade mark, two diamonds separated by W-S.

American Cyanamid Co.'s refinery chemicals department has opened a sales office in Cleveland at 711 Leader Bldg. Charles H. Groezinger, Jr., has been transferred from the Chicago sales office to Cleveland.

 (To obtain more data on advertised products see page 122)

Oil Man's Calendar

FEBRUARY

Western Petroleum Refiners Ass'n., regional meeting, Shamrock Hilton Hotel, Houston, Texas, Feb. 2-3.
American Society for Testing Materials, Committee D-2 on Petroleum Products and Lubricants, Statler Hotel, Dallas, Texas, Feb. 5-10.
American Institute of Mining and Metallurgical Engineers, annual meeting, Hotel Statler, New York, Feb. 19-23.
Natural Gasoline Ass'n. of America, Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas, Feb. 25.
National Society of Professional Engineers, spring meeting, Hotel Statler, Washington, D. C., Feb. 24-25.
American Institute of Chemical Engineers, national meeting, Hotel Statler, Los Angeles, Feb. 26-29.

MARCH

Chemical Institute of Canada, 6th divisional conference, Guildwood Inn, Sarnia, Ont., March 5-7.
National Assn. of Corrosion Engineers, corrosion conference and show, Hotel Statler, New York, March 12-16.
Western Petroleum Refiners Assn., annual, Plaza Hotel, San Antonio, March 19-21.

APRIL

American Institute of Electrical Engineers, southwest district No. 7, Dallas, Apr. 2-4.
Corrosion Control Short Course, central Oklahoma section of NACE and University of Oklahoma, University Extension Study Center, Norman, Apr. 3-5.
American Society of Lubrication Engineers, annual, William Penn Hotel, Pittsburgh, Apr. 4-6.
Natural Gasoline Assn. of America, annual, Texas Hotel, Ft. Worth, Apr. 11-13.
National Petroleum Assn., semi-annual, Hotel Cleveland, Cleveland, Apr. 18-20.
World-Oil Exposition, Houston, Apr. 25-29.
American Institute of Electrical Engineers, 2nd Conference on Recording and Controlling Instruments, Bradford Hotel, Boston, Apr. 26-27.

MAY

American Institute of Electrical Engineers, northwestern district, Rochester, N. Y., May 2-4.
Liquefied Petroleum Gas Assn., convention and trade show, Conrad Hilton Hotel, Chicago, May 6-9.
American Welding Society, 4th Welding Show, Memorial Auditorium, Buffalo, N. Y., May 9-11.
American Petroleum Institute, Refining Division mid-year meeting, Sheraton-Mt. Royal Hotel, Montreal, May 14-17.
11th Purdue Industrial Waste Conference, Purdue University, Lafayette, Ind., May 15-17.
Chemical Institute of Canada, annual, Mt. Royal Hotel, Montreal, May 28-30.

JUNE

American Society for Testing Materials, annual, with apparatus exhibit, Chalfonte-Haddon Hall, Atlantic City, June 17-22.
Western Petroleum Refiners Assn., regional technical-industrial relations, Broadview Hotel, Wichita, Kan., June 21-22.

The "Ceramo" thermocouples to be used to measure temperatures for evaluation of efficiency and safety of the "Seawolf's" atomic reactors have Stainless Steel sheaths and Chromel-Alumel thermocouple wires.*

T-E'S NEW "Ceramo" THERMOCOUPLES WILL BE USED TO CHECK REACTOR TEMPERATURES ON ATOMIC SUB "SEAWOLF."

Where the conditions are the toughest—where heat, corrosion and radiation have made it difficult to write a specification—you can depend on finding "Ceramo" thermocouples. The "Ceramo" sensing element of this new Thermo Electric thermocouple consists of a metal sheath, protecting two thermocouple wire conductors which are separated and firmly fixed in place by ceramic insulation.

Although this thermocouple is rugged enough to stand pressures of several thousand p.s.i. and temperatures to 1600° F., it may be bent to *any* configuration. "Ceramo" thermocouple extension wire is also available, in all standard thermocouple materials . . . comes in sizes from 1/16" to 1/4" diameter.

Get all the latest information on these new metal-clad, ceramic-insulated wires and thermocouples.

Write for Bulletin 31-300-I.

*Photo Courtesy Electric Boat Division of General Dynamics Corp. and U.S. Navy

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Quick-Coupling Connectors and Panels • Thermocouple and Extension Wires

Thermo Electric Co., Inc.
Rochelle Park Post Office, SADDLE BROOK, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

(To obtain more data on advertised products see page 122)

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Anthracite Institute Bldg., Wilkes-Barre, Pa.

Standard of Indiana—from 1889 to 1951

Standard Oil Company (Indiana), by Paul H. Giddens, 1955, 7 x 10 in., 741 pp., indexed, illustrated, $7.50, Appleton-Century-Crofts, Inc., 35 W. 32nd St., New York 1, N. Y.

Once an important part of John D. Rockefeller's mighty oil empire, now a fully independent and integrated company, Standard Oil Co. (Ind.) had risen to be the second largest oil company and the fourth largest industrial enterprise in the U.S. by 1951.

Starting with the formation of the Standard Oil Co. (Ind.) in 1889 when Rockefeller started "hazardous purchases" of "worthless" high-sulfur crude from the Lima, Ohio, area, Dr. Giddens has traced the company's history with full access to company records and no restrictions on what to write.

To assure objective and impartial writing of the book, Standard Oil Co. (Ind.) made a research grant to Allegheny College, and promised to cooperate to the fullest extent.

The modern history of the company starts in 1911 when the Supreme Court dissolved the Standard Oil Co. (N.J.), releasing 33 new, free, and separate companies. The newly independent Standard Oil Co. (Ind.) found itself with three large refineries and an extensive marketing organization, but no crude supply or pipeline system. It was content to operate as a refiner and marketer until 1917 when it began to purchase proven crude oil properties.

Then, starting around 1920, the company made several other acquisitions which not only increased its crude reserves, but marked the start of an extensive pipeline system, which today handles more traffic than any other pipeline system in the world. In addition the company met its long range objective of crude oil production equal to at least 50% of their refinery runs.

In 1932, a subsidiary (Stanolind Oil and Gas Co.) began the company's first program of active exploration, wildcatting and development to supplement holdings in proven crude reserves.

Important technical pioneering efforts included the first commercial scale use of Frasch's copper oxide process to remove sulfur from crude, providing a market for "useless," high-sufur, Ohio-Indiana crude; and the development of the Burton thermal cracking process, doubling the amount of gasoline available from crude.

In all, *Standard Oil Company (Indiana)* by Dr. Giddens is an account of the company's growth, struggles, operations, policies, and practices—all phases of its business.

The author, Paul H. Giddens, is well known for his oil industry books, previous ones including "The Birth of the Oil Industry," "The Beginning of the Petroleum Industry," and "The Early Days of Oil." Though heading the History and Political Science Dept. at Allegheny College during the writing of his latest book, Dr. Giddens is now president of Hamline University in St. Paul, Minn.

Recent Books Briefly Noted

How to Organize and Operate Photographic Service Departments, 1st ed., 1955, 5¾ x 8½ in., 60 pp., table of contents, illustrated, heavy paper cover, $0.50, Eastman Kodak Co., Editorial Service Bureau, Rochester 4, N. Y.

. . . a practical approach to two general problems in industrial photography: starting a photographic service department and operating one efficiently after it is established.

The Automatic Factory—A Critical Examination, 1955, by S. A. June, J. D. Bardis, L. H. Lurio, L. S. Polaner, O. Sagedahl, H. A. Sklenar, and B. K. Yenkin, 5½ x 8¼ in., 88 pp., table of contents, illustrated, cloth cover, $1.50, The Instruments Publishing Co., Pittsburgh 12, Pa.

. . . a joint report by seven candidates for the degree of Master of Business Administration resulting from their travels and investigations during a six months' period.

Field Evaluation of Houdry Catalytic Exhaust Converters, June 1955, by Southwest Research Institute, San Antonio, Tex., 8½ x 11 in., 77 pp., table of contents, illustrated, heavy paper cover, $3.00, Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, Calif.

. . . discusses field tests of the Houdry catalytic converter for the reduction of hydrocarbon emissions from automobile mufflers.

Hawley's Technical Speller, 1955, compiled by G. G. Hawley, and A. W. Hawley, 5¼ x 7½ in., 146 pp., table of contents, cloth cover, $2.95, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . contains over 8,000 difficult technical words selected from chemistry, physics, engineering, electronics, biology, medicine and other fields of science and technology—giving their correct spelling and syllable separation.

Qualitative Organic Analysis and Scientific Method, 1955, by A. McGookin, 5¾ x 8¾ in., 155 pp., index, stiff cloth cover, $4.50, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . outlines a practical scheme of organic analysis based on scientific method rather than mere laboratory technique, as used by the author for over 30 years with all types of chemistry students.

Introduction to Electronic Analogue Computers, 1955, by C. A. A. Wass, 5¾ x 8¾ in., 237 pp., index, illustrated, stiff cloth cover, $6.50, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

. . . an informed, detailed, up-to-date report on the present status of analogue computers—constituting a professional description of analogue differential analyzers and their components—discussing both theory and design.

Introduction to the Study of Chemical Reaction in Flow Systems, 1955, by F. S. Penner, 6½ x 10 in., 86 pp., index, stiff cloth cover, $3.00, Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.

. . . an introduction to the study of chemical reactions in moving ideal gas mixtures with a summary of the principles of practical chemical kinetics and basic material for formulation of flow problems with chemical reaction.

Combustion Researches and Reviews, 1955, invited papers presented at the 6th and 7th Agard Combustion Panel Meetings held respectively in Scheveningen, The Netherlands, May 1954 and in Paris, France, November 1954, 6½ x 10 in., 187 pp., index, illustrated, stiff cloth cover, $5.00, Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.

. . . contains papers printed in both English and French discussing problems and theory of flame stabilization and spray formation and combustion.

Consulting Services, 15th Ed., 1955, 6 x 9 in., 144 pp., $1.00 on letterhead request giving source of reference, name of person and company, and complete address including postal zone number, Association of Consulting Chemists and Chemical Engineers, Inc., 50 E. 41st St., New York 17, N. Y.

. . . classifies over 200 items of activity cross-referenced to members of the Association of Consulting Chemists and Chemical Engineers, Inc.; describes scope of each member's qualifications and activities; and gives other organizations and affiliations of the consulting members.

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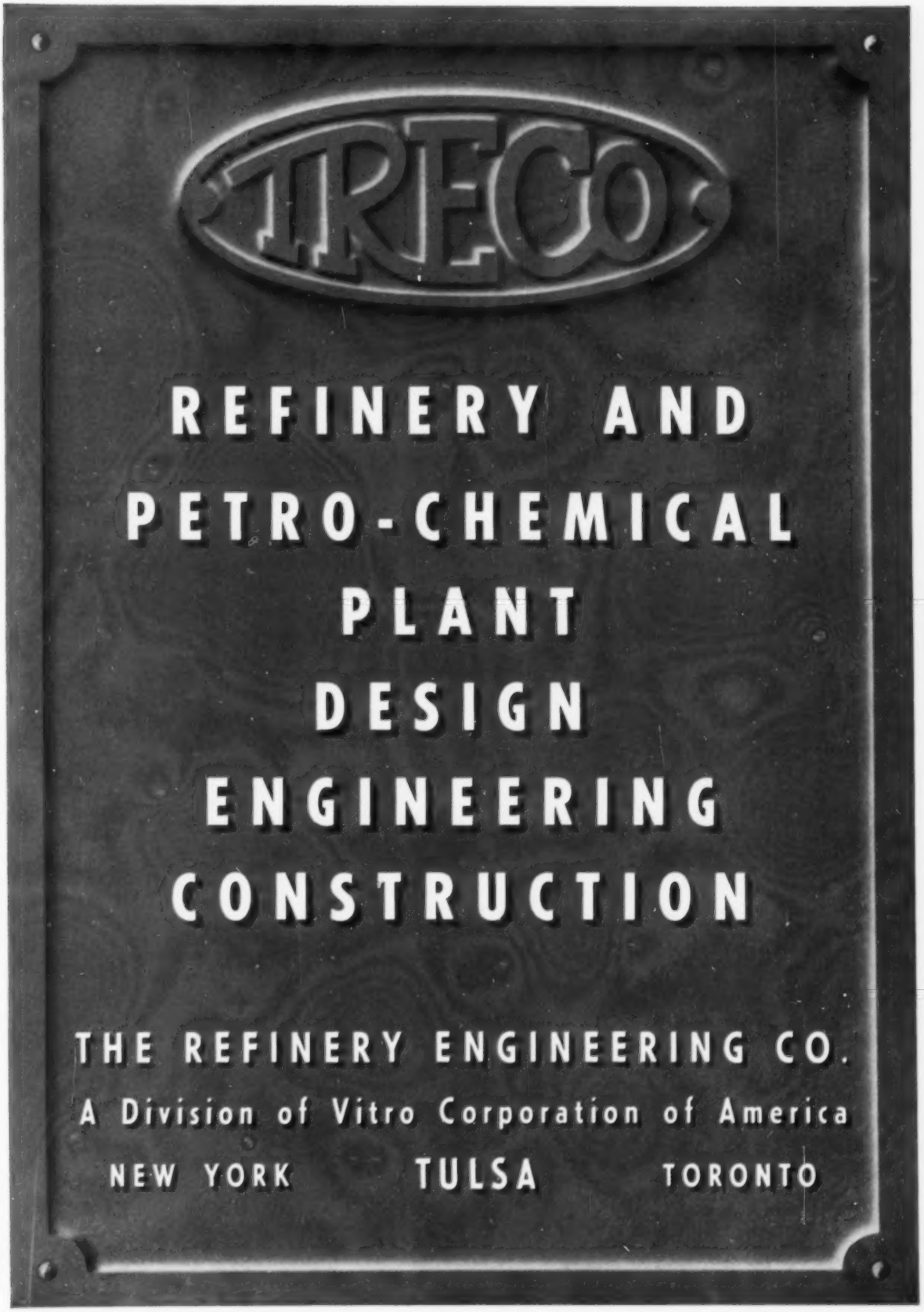
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Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

BARIUM CHEMICALS, for lube oil additives, booklet; Westvaco Mineral Products. See adv't. p. 29.

BORON CARBIDE, for atomic energy applications, booklet; Norton Co. See adv't. p. 111.

CATALYSTS, many types, in seven forms, booklet; Harshaw Chemical Co. See adv't. p. 100.

CHLORINATION SYSTEMS, to control slime, booklet RA-2061-C; Wallace & Tiernan, Inc. See adv't. p. 138.

COMPRESSORS, centrifugal, and axial flow, booklet; Carrier Corp. See adv't. p. 35.

COOLING TOWERS, technical brochures; The Marley Co. See adv't. p. 106.

DE-WAXERS, and de-oilers, rotary drum vacuum filters, test data; Goslin-Birmingham Mfg. Co. See adv't. p. 143.

DISTILLATION EQUIPMENT, bulletin 55-1; Distillation Engr. Co. See adv't. p. 116.

DRYING AGENTS, dessicants, information; Minerals & Chemicals Corp. See adv't. p. 23.

FILTERS, for water, information on request; Anthracite Equipment Corp. See adv't. p. 116.

FLOOR MAINTENANCE equipment, scrubbers, factbook; American Floor Surfacing Machine Co. See adv't. p. 116.

FURFURAL, for solvent extraction, bulletin 203-A; Quaker Oats Co. See adv't. p. 137.

HEAT ENCLOSURES, booklet describes construction methods; M. H. Detrick Co. See adv't. p. 129.

HOT PLATES, for laboratory use, bulletin 1001-A; Lindberg Engineering Co. See adv't. p. 142.

INSULATION, for piping, snaps on, brochure and sample; Gustin-Bacon Mfg. Co. See adv't. p. 34.

LINED PIPE, saran swaged into steel, information; Saran Lined Pipe Co. See adv't. p. 135.

METAL DEACTIVATOR, to control copper compounds in gasoline, booklet; DuPont Co. See adv't. p. 106B.

MIST ELIMINATORS, wire mesh, bulletin 203; Schuyler Mfg. Corp. See adv't. p. 17.

MIXERS, and mechanical seals, 8 catalogs and bulletins: Mixing Equipment Co. See adv't. p. 42.

MIXING, by jet eductors, condensed bulletin J-1; Schutte & Koerting Co. See adv't. p. 24.

MORE ECONOMIC OCTANES, a 50 page economic analysis; Ethyl Corp. See adv't. pp. 4-5.

MOTOR STARTERS, for hazardous locations, booklet 1062; Electric Controller & Mfg. Co. See adv't p. 146.

OXYGEN ANALYZER, continuous measurement, data file 16J-26; A. O. Beckman, Inc. See adv't. p. 150.

PACKING, metallic, for hot oil charge pumps, catalog; Crane Packing Co. See adv't. p. 136.

PAINT STRIPPER, special report B-2415 and handbook F-7893; Oakite Products, Inc. See adv't. p. 140.

POTENTIOMETER TRANSMITTER, electronic-pneumatic, catalog 98262; Taylor Instrument Co. See adv't. pp. 82-83.

PRESSURE GAGES, solid front, pneumatic transmission systems, file 20B; Norden Ketay Corp. See adv't. p. 28.

PUMPS, stuffingboxless, for high suction pressures, bulletin 107; Bingham Pump Co. See adv't. p. 33.

REFRACTORIES, color movie describes the refractories industry; General Refractories Co. See adv't. p. 121.

REFRACTORY LININGS, hydraulic, for trowel or gun, brochure RC-28A; Johns-Manville Corp. See adv't. p. 144.

STAINLESS STEEL, for refineries, booklet; U. S. Steel Corp. See adv't. p. 22.

STEAM TRAPS, new bulletin 10-55; W. H. Nicholson & Co. See adv't. p. 147.

STEEL FABRICATION, process equipment, general catalog; Flint Steel Corp. See adv't. p. 132.

SYNTHETIC AMMONIA, plant designs, booklet; M. W. Kellogg Co. See adv't. p. 153.

TEMPERATURE INDICATORS, and recorders, new catalog; Electric Auto-Lite Co. See adv't. p. 134.

THERMOCOUPLES, ceramic insulated, metal clad, bulletin 31-300-I; Thermo Electric Co., Inc. See adv't. p. 115.

TOWER PACKING, booklet; U. S. Stoneware Co. See adv't. p. 40.

TUBE CLEANING and expanding tools, literature; Airetool Mfg. Co. See adv't. p. 95.

TUBING, heat exchanger and condenser, booklet and catalog; Wolverine Tube. See adv't. pp. 36A-36B.

TURBINES, steam, horizontal, new models described in catalog 500; Dean Hill Pump Co. See adv't. p. 84.

UNIONS, for various pressures and temperatures, catalog 11; Catawissa Valve & Fittings Co. See adv't. p. 95.

VACUUM CLEANER, explosion proof, information; Doyle Vacuum Cleaner Co. See adv't. p. 140.

VALVES, and pressure gages, heated or cooled, for cold or hot liquids, data units 237 & 252; Jerguson Gage & Valve Co. See adv't. p. 110.

VALVES, drop forged steel, catalog supplement No. 1; Henry Vogt Machine Co. See adv't. p. 25.

VESSEL LININGS, many types, catalog; Begilow-Liptak Corp. See adv't. p. 151.

GENERAL REFRACTORIES

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FOR INFORMATION ON ANY PRODUCT OR SERVICE IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products, or services which interest him. This code letter appears in parantheses following the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

ADVERTISERS' INDEX

A

Airetool Mfg. Co. (E-5) 95
Air Preheater Corp. (F-7) 112
American Bitumals & Asphalt Co. (J-1) 148
American Cyanamid Co., Refinery Chem. Dept. (J-2) 149
American Floor Surfacing Machine Co. (G-1) 116
Anthracite Equipment Corp. (G-3) 116

B

Baker & Co. (D-6) 81
Baldwin-Hill Co. (E-1) 90
Beckman, Inc., A. O. (J-3) 150
Betz, W. H. & L. D. (C-8) 36
B-I-F Industries, Proportioneers (A-1) Cover 2
Bigelow-Liptak Corp. (J-4) 151
Bingham Pump Co. (C-5) 33
Black, Sivalls & Bryson, Inc. (I-3) 141

C

Carrier Corp. (C-7) 35
Catawissa Valve & Fittings Co. (E-4) 95
Cleveland Wire Cloth & Mfg. Co. (F-8) 114
Cooper-Bessemer Corp. (B-4) 21
Crane Co. (D-9) 86
Crane Packing Co. (H-7) 136

D

Davison Chemical Co., Div. W. R. Grace & Co. (C-4) 32
Dean Hill Pump Co. (D-8) 84
Dempster Brothers, Inc. (C-3) 30-31
Detrick Co., M. H. (G-8) 129
Distillation Engr. Co. (G-2) 116
Dow Chemical Co. (H-6) 135
Doyle Vacuum Cleaner Co. (I-2) 140
DuPont de Nemours & Co., Inc. (B-3) 20A-20B
DuPont de Nemours & Co., Inc. (F-3) 106B
Durametallic Corp. (H-5) 134

E

Electric Auto-Lite Co. (H-4) 134
Electric Controller & Mfg. Co. (I-8) 146
Enjay Co. (E-2) 91
Ernst Water Column & Gage Co. (E-8) 104
Ethyl Corp. (A-3) 4-5
Ever-Tite Coupling Co., Inc. (G-7) 128

F

Flint Steel Corp. (H-2) 132
Fluor Products Co. (J-8) Cover 4
Foster Wheeler Corp. (D-2) 38-39

G

Gen'l American Trans. Corp., Plate & Welding Div. (A-4) 6
Gen'l American Trans. Corp., Terminals Div. (A-5) 8
General Chemicals Div., Allied Chem. & Dye Corp (J-7) Cover 3
General Refractories Co. (G-6) 121
Goslin-Birmingham Mfg. Co. (I-5) 143
Gustin-Bacon Mfg. Co. (C-6) 34

H

Harshaw Chemical Co. (E-7) 100
Houdry Process Corp. (E-6) 96
Hudson Engineering Corp. (D-4) 41

J

Jerguson Gage & Valve Co. (F-4) 110
Johns-Manville Corp. (I-6) 144

K

Kellogg Co., M. W., Chemical Process Div. (J-6) 153
Kellogg Co., M. W., Fabricated Prods. Div. (B-2) 20

L

Lindberg Engineering Co. (I-4) 142
Lummus Co. (A-7) 13

M

Marley Co. (F-1) 106
McKee Co., Arthur G. (E-9) 105
Minerals & Chemicals Corp. (B-6) 23
Mixing Equipment Co. (D-5) 42
Moore & Co., Samuel (A-8) 14

N

Nicholson & Co., W. H. (I-9) 147
Norden Ketay Corp. (C-1) 28
Norton Co. (F-5) 111

O

Oakite Products, Inc. (G-9) 140
Oilwell Supply Co. (A-2) 1
Oronite Chemical Co. (I-7) 145

P

Petro-Chem Development Co. (E-3) 92
Petreco (F-2) 105A
Powell Co., William (H-1) 131
Procon, Inc. (I-1) 139

Q

Quaker Oats Co. (H-8) 137

R

Refinery Engineering Co. (G-5) 119
Ridge Tool Co. (D-1) 37
Rockwell-Nordstrom Valves (B-9) 26-27

S

Schutte & Koerting Co. (B-7) 24
Schuyler Mfg. Corp. (A-9) 17
Scovill Mfg. Co. (A-6) 11
Struthers Wells Corp. (H-3) 133

T

Taylor Instrument Cos. (D-7) 82-83
Thermo Electric Co., Inc. (F-9) 115
Tickle Engr. Works, Arthur (J-5) 152
Tretolite (G-4) 118

U

U. S. Steel Corp. (B-5) 22
U. S. Stoneware Co. (D-3) 40
Universal Oil Products Co. (B-1) 18-19

V

Vogt Machine Co., Henry (B-8) 25

W

Wallace & Tiernan Products, Inc. (H-9) 138
Westvaco Mineral Products (C-2) 29
Wolverine Tube, Div. Calumet & Hecla, Inc. (C-9) 36A-36B

CLASSIFIED ADVERTISING
F. J. Eberle, Ass't Mgr.

EMPLOYMENT OPPORTUNITIES 108, 109
EQUIPMENT (Used or Surplus New) For Sale 108

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21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

B—ADVERTISED PRODUCTS *See Index on facing page*

A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	O1	P1	Q1	S1	T1	U1	V1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	O2	P2	Q2	S2	T2	U2	V2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	O3	P3	Q3	S3	T3	U3	V3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	O4	P4	Q4	S4	T4	U4	V4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	O5	P5	Q5	S5	T5	U5	V5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	O6	P6	Q6	S6	T6	U6	V6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	O7	P7	Q7	S7	T7	U7	V7
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C—REPRINTS AVAILABLE *See listing on next page*

R1	R4	R7	R10	R13	R16	R19	R22	R25	R28	R31	R34	R37	R40	R43	R46
R2	R5	R8	R11	R14	R17	R20	R23	R26	R29	R32	R35	R38	R41	R44	R47
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First issue of February, 1956 (Void until May 15, 1956)

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61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

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A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	O1	P1	Q1	S1	T1	U1	V1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	O2	P2	Q2	S2	T2	U2	V2
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A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	O4	P4	Q4	S4	T4	U4	V4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	O5	P5	Q5	S5	T5	U5	V5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	O6	P6	Q6	S6	T6	U6	V6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	O7	P7	Q7	S7	T7	U7	V7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	O8	P8	Q8	S8	T8	U8	V8
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R1	R4	R7	R10	R13	R16	R19	R22	R25	R28	R31	R34	R37	R40	R43	R46
R2	R5	R8	R11	R14	R17	R20	R23	R26	R29	R32	R35	R38	R41	R44	R47
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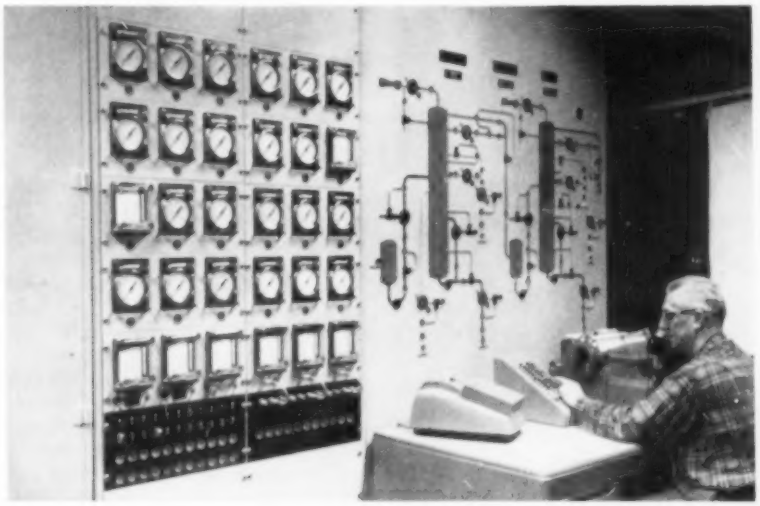


Intelligence Center

Coordinates All Process Data

An integrated unit, Taylor Instrument Co.'s TSL Control system is a collection of existing instrument components. The system compactly combines a graphic process panel, a control panel, and a control center in one unit.

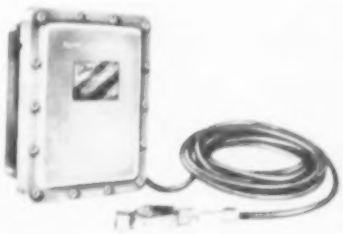
Two basic functions of process control are obtained with this system: automatic scanning and logging. Up to 100 process variables can be monitored continuously, with their values recorded periodically in printed form on an automatic typewriter. Any off-normal conditions signal the TSL operator (both audibly and visually), and the auxiliary printer will record the off-normal values until the process is again under control.

Point scanning is at the rate of one point/sec. A signal light glows for each point being scanned and tells its condition: white for normal, red, above normal, and amber for below normal. The order of scanning the process points can be altered by re-plugging the relay rack.

One unusual feature is the ability to replace an indicator with a recorder, and obtain a continuous record of abnormal conditions. If a process irregularity shows up on an indicator, the indicator can be un-plugged and a recording instrument plugged-in in a few seconds to record the trend of the disturbance. Careful analysis of the trouble can be made later during normal operations.

Data may be received from the process units by pneumatic or electrical transmission. It is converted to electrical impulses for use in logging or digitizing equipment. The system is able to tie-in with any standard electronic data handling system using punched cards, tape or other means of record keeping. **Taylor Instrument Companies,** 95 Ames Street, Rochester 1, N. Y.

Circle No. **1** *on Reply Card*



Grounding Device

. . . **is approved by Underwriter's Laboratories** for use in hazardous locations.

As a result of improvements, the Gilbarco Indicator is listed by Underwriter's Lab as a means of draining off static electricity accumulated during loading and unloading operations of tank cars and trucks. Essentially a balanced bridge circuit, the device operates on 115-volt, 60-cycle a.c. A miniature-type electronic tube is the power source.

A proper ground produces a minute radio signal, making available a control that can be used to light a pilot lamp, start pumps or actuate other electrical circuits. The Indicator is housed in a small, explosion-proof cast aluminum case; attached are 25 feet of standard heavy-duty cable and a large alligator clip. As optional equipment is a retracting reel for cable protection. **Gilbert & Barker Mfg. Co.,** West Springfield, Mass.

Circle No. **2** *on Reply Card*

Oil-Resistant Gloves

. . . **are coated with vinyl resins** that resist oils, gasolines, acids and other chemicals.

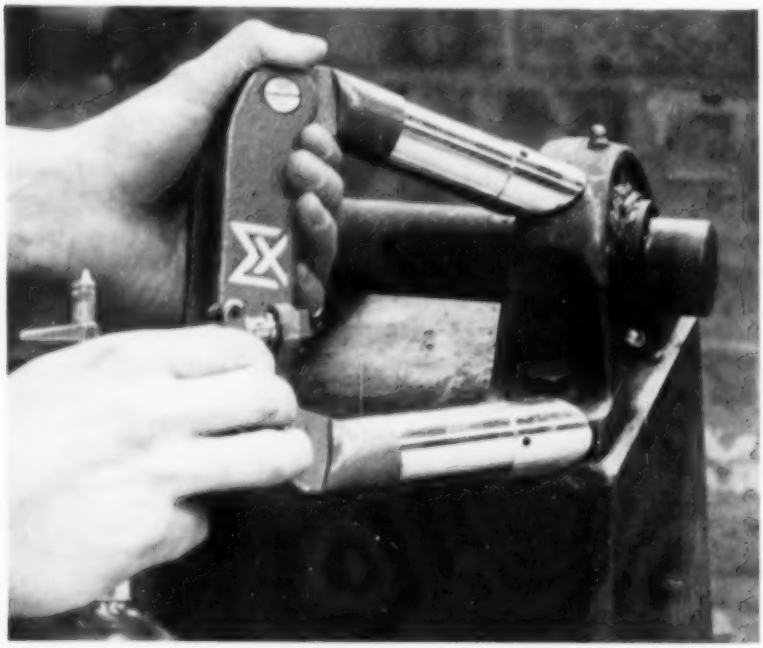
The durable and flexible coating is fused to a string fabric liner to resist snags and tears. These work gloves will stay flexible after a 24-hour bath in solvents such as gasoline, kerosene, naphtha, mineral spirits and petroleum oils—according to the manufacturer.

Six styles are available: mittens, knit-wrist, band-top, and gauntlet with long or short safety cuffs. All are coated with Bakelite vinyl resins. **Plasticote Glove Co.,** Inc., 102 East Walnut St., Milwaukee 12, Wis.

Circle No. **3** *on Reply Card*

Business Address _____

City _____ Zone ____ State ____



Magnetic Tester

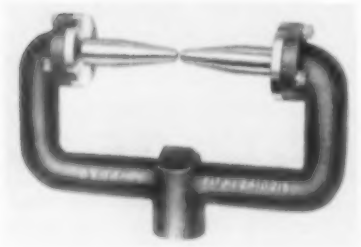
Inspects In Hazardous Areas

No electrical power is needed to use this kit for finding surface or fatigue cracks in operating equipment. Heretofore this type equipment could not be used any place where electrical arcing might cause an explosion.

This Magnaflux YM-5 Yoke kit develops a pull of over 40 pounds on a flat surface, using Alnico permanent magnets in a new magnetic circuit. Inspection of critical parts is made by spraying the magnetic particles over the part, and then using the magnetic yoke. The yoke legs are hinged and the angle-cut tips rotate so that good magnetic contact can be made on almost any shape part.

The total kit weighs 22 pounds, complete with a metal case. It includes a spray gun, two powder bulbs, wet-bath and dry powder magnetic particle materials—as well as the 5-lb. yoke itself. **Magnaflux Corp.,** 7300 West Lawrence Ave., Chicago 31, Ill.

Circle No. **4** *on Reply Card*



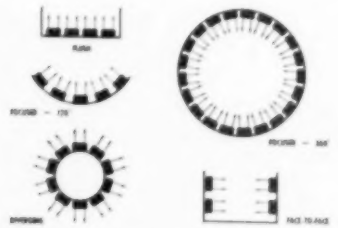
Fire Fighting Nozzles

. . . **create atomized fog** from nozzle tips of patented design.

These new Bete nozzles produce laminar flow at the point of impingement, generating a clear, laminar sheet. This sheet breaks up into extremely fine droplets as the two opposing streams issue from the nozzles. This action, the manufacturer reports, results in uniform droplets of the highest possible atomization.

Since there are no internal parts to wear or clog, maintenance is claimed to be low. The "O.J. Series" nozzles are available in four standard sizes, ranging in flow rate from 3 to 30 gpm. Pipe connections are ⅜, ¾, 1, and 1½-in.; overall dimensions are 6, 9, 12, and 18-in. Standard nozzles are made of bronze or aluminum, with special orders available in stainless steel, teflon and other materials. **Bete Fog Nozzles, Inc.,** 309 Wells St., Greenfield, Mass.

Circle No. **5** *on Reply Card*



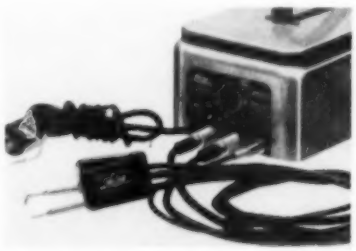
Ultrasonic Cleaning

. . . **of metals** is accomplished with hermetically sealed transducers.

For metal cleaning applications, such as removing soldering flux, carbon smut, buffing compounds or radioactive contaminants, these transducers operate with generators at 40 kc/sec. Installed in banks, the transducers can radiate areas up to 8 sq. ft. The modular design of the transducer allows a wide choice of arrangements for focusing the sonic energy. Several typical arrangements are shown in the drawing.

Individual transducers radiate an area of 2⅝ x 6 in. Costs, including the generating equipment, ranges from $23/sq. in. of radiating surface down to $14/sq. in. for multiple installations. **Branson Ultrasonic Co.,** 194 Richmond Hill Ave., Stamford, Conn.

Circle No. **6** *on Reply Card*



Portable Precision Welder

. . . **designed for strain gage attachment,** joins dissimilar metals and parts of varying thicknesses.

The Weldmatic Model 1016 is complete in itself, and comes equipped with two interchangeable handpieces. It will accommodate the entire range of metal-foil-backed strain gages now being developed for welding directly to steels, super alloys, aluminum and other materials.

Welding energy, operating from any 115-volt AC outlet, is adjustable over a wide range. Output is held constant by a regulated power supply and permits unifirm welds. **Unitek Corp.,** 275 N. Halstead Ave., Pasadena 3, Calif.

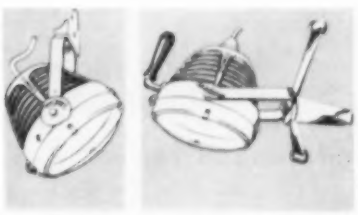
Circle No. **7** *on Reply Card*

Metallizing Machine

. . . **features uniform feeding** of metal wire without fluctuation.

A dynamically balanced air turbine provides a positive power control for the feeding wire. It is governed by the air fed to a primary and secondary turbines, so arranged that their opposing forces are in direct proportion to any change of air volume or pressure. A self contained gas mixing chamber nozzle is claimed to eliminate completely the danger of backfire from the melting chamber. The machine weighs 4½ lbs. **Vandersee Corp.,** Route 22, Union, N. J.

Circle No. **8** *on Reply Card*



Outdoor Floodlight

. . . **produces 115,000 candlepower** with a 500 watt rating.

This new unit concentrates its entire light output in an oval-shaped, high-intensity beam that allows mounting the light at some distance from the area to be lighted. It is constructed of heavy-duty, non-corrosive, cast aluminum throughout. Heavy internal and external ribs provide a large heat dissipation surface.

Lamp life is claimed at 2,000 hours, and the lamp is cradled in a high-temperature rubber cushion-seal which protects it from shock or abuse. A cast aluminum hinged cover ring, with heat-tempered clear, spred or colored lenses, seals the lamp from the weather. A swivel with locking teeth allows fixing the beam permanently.

For portable use the unit is supplied with a quick-disconnect socket and cord, carrying handle, and cast aluminum tripod. **Stonco Electric Products Co.,** 333 Monroe Ave., Kenilworth, N. J.

Circle No. **9** *on Reply Card*

Natural Gasoline Purifier

. . . **separates all liquid and mist** entrained in butane, methane, propane and hydrocarbon gases.

Using a patented two-stage principle, the first stage removes the larger droplets of entrained liquid or mist by impingement against a baffle. The fine mist is removed in the second stage by centrifugal action.

Compact in size, the six-inch size shown measures 34-in. long and 16-in. in diameter. Maintenance is low since there are no moving parts. Entrained liquids are drained automatically and continuously through a drain outlet at the base of the purifier, by a float type trap.

These Hi-eF Type L purifiers are available in sizes from 2½-in. through 10-in., and design pressures up to 300 psi. Other sizes and pressures are available upon special application. Material of construction is welded carbon steel and special alloys. **V. D. Anderson Co.,** 1935 West 96th St., Cleveland 2, Ohio.

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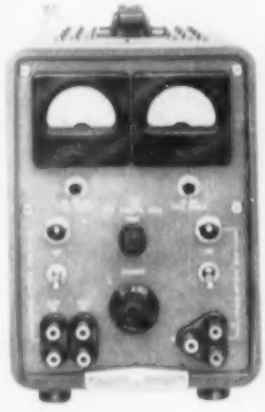

Power Supply

. . . **for all types of electronic setups** is lightweight and enclosed in an all-metal carrying case.

The Model 711A is a completely new power supply with a range of 0 to 500 volts, with no-load to full-load regulation of better than ±0.25% or 0.5 volts. Ripple is less than 1 millivolt. Separate current and voltage meters have push-button range switching for measurement of very small voltages and currents. Complete overload protection, plus grounding of either positive or negative dc terminals, is provided.

Weighing 18 lbs., this power supply is designed for all types of laboratory, field and factory electronic test setups. **Hewlett-Packard Co.,** Dept. P, 395 Page Mill Road, Palo Alto, Calif.

Circle No. **11** *on Reply Card*

Polyvinyl Chloride Pipe

. . . **and fittings by Corning Glass** is designed for low-cost conveying of corrosive fluids at moderate temperatures (under 140°F.).

This new line of rigid unplasticized PVC pipe is available in 10-ft. or custom-ordered 20-ft. lengths. It can be readily cut, sawed and threaded with conventional pipe tools. The opaque, grey-pigmented thermoplastic pipe is available with valves of the same material made by Lunkenheimer Co. The PVC pipe, which weighs only 40 lbs.

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Standard Adapter
and Coupler

Your best buy is

EVER-TITE
-the best quality
QUICK COUPLINGS

EVER-TITE
Adapter and
Coupler

EVER-TITE
Shank Hose
Coupling

You save *time* and *money* when you use Ever-Tite Couplings because they speed-up deliveries, prevent leakage, and save wear on equipment.

Tightness is predetermined in manufacture by positive gasket compression. There are no sliding rings—no springs, ball bearings, snaps or lugs to fit. You just slip the coupler over the adapter, and close the handles.

If you want to get the *most* in coupling value get *Ever-Tite*. The Ever-Tite Trademark is a hallmark of dependability in fittings for the petroleum industry—proved by 18 years of pre-eminence. Ask your distributor now.

EVER-TITE COUPLING CO. INC.
254 West 54th Street
New York 19, N. Y.

Dust Plug

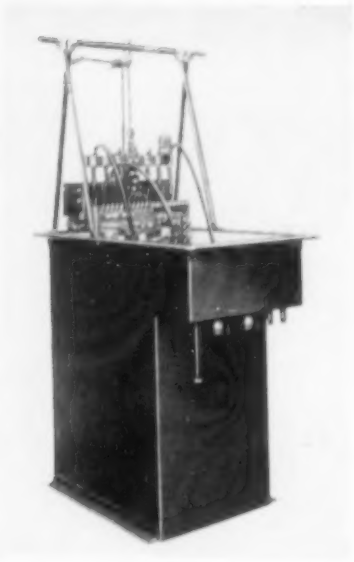
Dust Cap

EVER-TITE Dust Protectors

Every EVER-TITE saves time and money

for a 100-ft. length of one-inch size, is available from the regular distributors of **Corning Glass Works,** Corning, N. Y.

Circle No. **12** *on Reply Card*



High Voltage Starter

. . . **has all electrical units immersed in oil,** and is designed for Division 2 hazardous locations.

Designed with 50, 000 KVA interrupting capacity, the new starter has all parts immersed under a large head of oil. The contactor is the ZHS magnetic type. All power and control leads are brought out of the oil through anti-syphon joints to a self-contained conduit connection box. A separate lifting mechanism allows raising the contactor above the oil level without disconnecting leads or removing bolts.

The starter is supplied in combination style with a self-contained disconnect switch. For those preferring to furnish their own means of disconnecting the motor and started circuit from the power source, it is also available without a disconnect switch. The unit is of Type III (weather proof) construction. **The Electric Controller & Mfg. Co.,** 4500 Lee Road, Cleveland 28, Ohio.

Circle No. **13** *on Reply Card*

Flame Arrestor

. . . **and tank vent prevents the spread of an external flame** into a storage tank while venting.

The Type 76-16 arrestor vent is a combination vent and cartridge type flame arrestor. The bottom part is an in-line arrestor; the top is a lightweight venting device with a modified base to fit the flame arrestor. It has a floating seal which provides positive shut-off under both pressure and vacuum. When the arrestor section is removed the vent will continue to operate.

Pressure and vacuum settings start at ½ oz/sq. in. Sizes available are from 4-in. to 12-in. **Black, Sivalls & Bryson, Inc.,** 7500 East 12th St., Kansas City 26, Mo.

Circle No. **14** *on Reply Card*

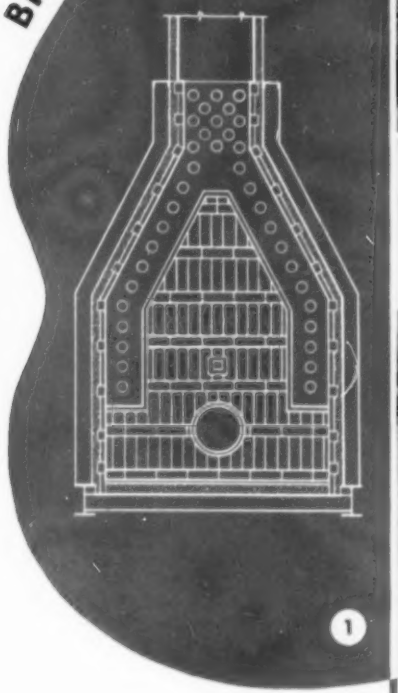
Automatic Valve

. . . **includes an integral positioner** in the superstructure.

The superstructure is a new concept in the design of diaphragm motor actuators. By inverting the topworks, without interfering with the open yoke or releasing compression of the stem packing, the valve can be converted to an air-to-close from an air-to-open type.

The body design provides an extra large bowl capacity and insures a high flow coefficient without involving excess body weight. Since all internal parts are removable through the valve bonnet, there is no need for a blind-head. Plugs in valves 2-in. and larger are of balanced design and can be supplied with a special device for tight shut-off, at any temperature and pressure condition. The S-3000 valves

BRING YOUR PROBLEMS TO HEAT ENCLOSURE HEADQUARTERS



Here you can draw on the reservoir of more than 40 years of experience in designing and engineering in this specialized field. Here you can put your trust in an organization that has had a life-long policy of making sure that the installation is a success. Here you will find heat enclosure designs engineered to make use of the latest developments of materials and methods.

For example—take note of the adaptability of Detrick construction to this packaged heater.

1. The drawing shows the composite wall, including thin refractory surface, backed up with ample insulation all securely supported to withstand the shock of transportation.
2. Installation of the Thermolayer wall was made in the shop under economical working conditions.
3. This illustration shows how the tile, insulation and a poured layer are held in position on supporting units; stud welded to the casing.
4. When completed, the whole unit is loaded onto a flat car for transportation to operating location.

Detrick is headquarters for information on heat enclosures. Day by day we are working on problems presented by every phase of industry. May we have an opportunity to work with you.

M. H. DETRICK COMPANY
111 W. Washington Street • Chicago 2, Illinois

SEND FOR BOOKLET

For a complete resume of the development of the art of enclosing heat, be sure to get your copy of **HEAT ENCLOSURE METHODS By DETRICK**, which will be sent on request.

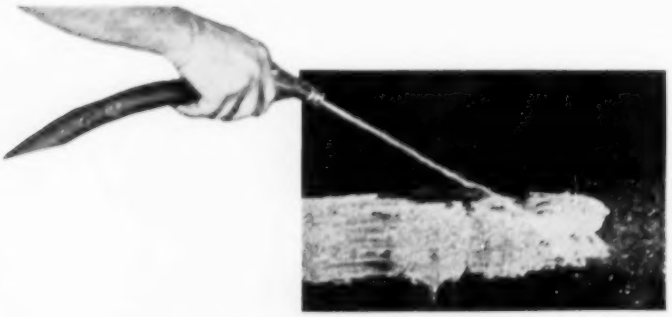
DETRICK Heat ENCLOSURES

DETRICK
HEAT ENCLOSURES

(To obtain more data on advertised products see page 122)

Amazing new stripper for removing paint!

BRUSH IT ON



RINSE IT OFF

Take a stop watch in one hand and a brush full of Oakite Composition No. 57 in the other and see for yourself how this amazing new paint stripper goes to work in seconds ... practically lifting the paint behind the brush.

See how Oakite Composition No. 57, paint stripper extraordinary, clings to vertical and inverted surfaces, eliminating costly waste. How easily loosened paint rinses away with water pressure spray.

Oakite Composition No. 57 is tops for removing those tough alkaline resistant paints from surfaces that just can't be dip-stripped. Get the full story today by writing for Special Report B–2415 and the Paint Stripping Handbook F–7893. Both FREE... Write Oakite Products, Inc., 44C Rector St., New York 6, N.Y.

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OAKITE.
MATERIALS · METHODS · SERVICE
SCIENCE

Export Division
Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

have four different spring ranges and low hysteresis. **Hammel-Dahl Co.,** 175 Post Road, Warwick Industrial Park, Providence 5, R. I.

Circle No. **15** *on Reply Card*

Gas and Liquid Analyzer

. . . **supplements distillation analysis** by selective solution (or sorption) of components of a flowing mixture. This method requires small samples (3 gas c.c.), requires 10 to 40 minutes, and is adequate where 1 to 4% accuracy is adequate.

The "Chromacon" apparatus employs the analytical technique first disclosed in 1941 by Dr. A. J. P. Martin, a Nobel Prize winner. The principle employed is the separation of components of a gas by their different solubility in a liquid solvent or solid adsorpent. The selective sorption takes place in a column having up to 2000 plates. Used with Podbielniak's Thermocon distillation apparatus, it is possible to make a simultaneous analysis of all low boiling hydrocarbons mixtures, including cracked C-4 and other fractions. **Podbielniak, Inc.,** 341 East Ohio St., Chicago 11, Ill.

Circle No. **16** *on Reply Card*

Plastic Coating Process

. . . **for metal parts** uses no flux, and allows different thicknesses of corrosion-resistant plastics to be attached to bare metal.

The "Whirlclad" process is carried out by dipping a pre-heated article into a fluidized bed of finely-divided coating material, such as nylon or polyethylene. The fluidized bed is achieved by ascending currents of air of gas or air.

By this imported process (from

PERFORMANCE VERIFIED / by acid test

Even before a Powell Corrosion Resistant Valve is made, it must pass the acid test. For quality control begins with the very materials which go into Powell Valves.

Constant laboratory control is one of the many ways we make certain that Powell Corrosion Resistant Valves will give dependable flow control. Another is the final step of manufacture: *every Powell Valve is subjected to an actual line test.*

To keep pace with the rapidly expanding chemical and process industries, Powell has designed many new types of Corrosion Resistant Valves. The variety of pure metals and special alloys in which they are available has grown to such an extent that today there is a Powell Corrosion Resistant Valve to control the flow of almost every known, corrosive fluid.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE PV VERIFIED

FIG. 1503 SS (Sectional)—150-Pound Alloy Steel Gate Valve.

FIG. 3065 SS (Sectional)—300-Pound Bolted Cap Alloy Steel Horizontal Lift Check Valve.

FIG. 1333 A (Sectional)—Integral Bonnet Angle Valve For Pressures of 1500 and 2500 W.S.P.

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

(To obtain more data on advertised products see page 122)

TULSA TYPE

HOW TO FEEL YOUNG AT 40

FLINT STEEL CORPORATION is a 40-year old firm, but we're still youthful in our outlook and ability to get things done. We retain our youth by keeping up with all the latest developments in steel plate fabricating with modern equipment. And, we've been fabricating specialized TULSA TYPE equipment for the petroleum and petrochemical industries for 30 years. This combination of long experience and modern machines goes to work for you whenever you call on FLINT STEEL. We earnestly invite you to discuss your plate fabricating problems with us at any time.

Write for our General Catalog

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TULSA, OKLAHOMA

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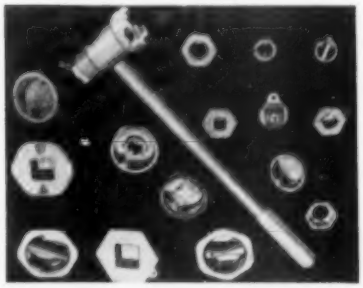
There's a new, easy way to order single copies of this reprint. Circle number "R3" in Area "C" of the Reader's Service Card in this issue —pages 127-128.

(New York City residents, add 3% city sales tax)

Germany) metals, glass or ceramics can be protectively coated with many low-melting materials which can impart their corrosion resistance to the treated object. **Polymer Processes, Inc.,** Reading, Pa.

Circle No. **17** *on Reply Card*

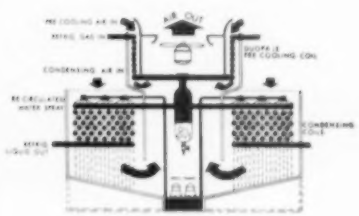


Spark-Proof Bung Wrench

. . . **fits fifteen different kinds** of plugs and vent caps used on steel drums and barrels.

This patented drum wrench eliminates the use of hammer-and-chisel in hazardous areas in turning unusual plug shapes. It has a head of machined steel, with both insert and socket type grips. A tubular steel handle with a knurled end gives a secure grip. The entire tool is cadmium plated to prevent sparking if struck against other metal. It weighs 2¼ lb. and is priced at $9.95. **Puget Sound Tools,** 515 2nd Ave. West, Seattle 99, Wash.

Circle No. **18** *on Reply Card*



Refrigerant Condenser

. . . **of new design** has removable panels for accessibility and shipment.

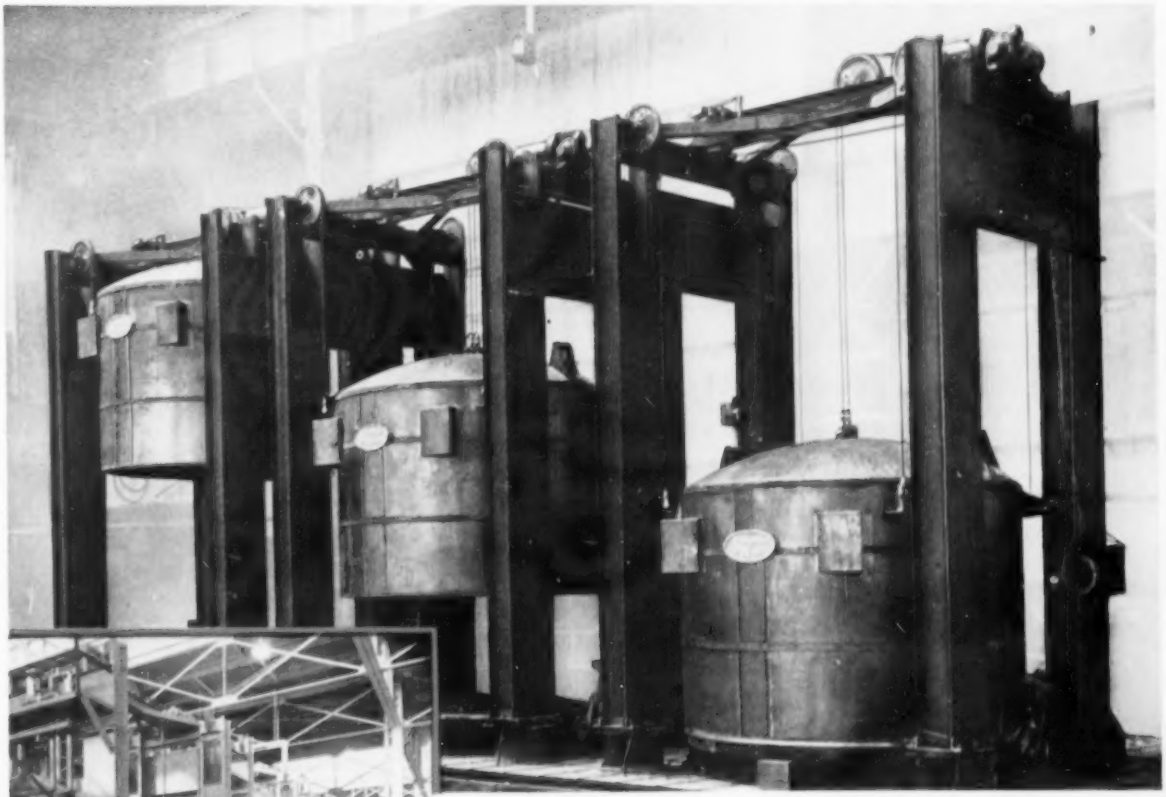
Ammonia (or freon) refrigerant is condensed in two parallel mounted coils, enclosing a central plenum under the fan section. Air enters from above the water sprays and must change direction before exiting through the propeller fans. This eliminates any entrained water. The only water consumed is that evaporated.

The hot gas is sub-cooled before condensation by first passing through precooling coils mounted beside the

Designed, engineered and built by Struthers Wells...

SPECIAL PROCESSING EQUIPMENT

meets all code specifications and your exact requirements



These shop and installation photos illustrate specially designed and engineered dryers for drying electrical cable under vacuum, with steam heat. Each is 8' in diameter x 6'6" high.

Struthers Wells—with unexcelled experience, research, engineering and modern equipped plants are constantly producing standard or specialized equipment such as that illustrated—for the process industries.

Call or write our nearest sales office or direct to our plant—for prompt attention and dependable handling of *your* process equipment requirements.

STRUTHERS WELLS PRODUCTS

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

CHEMICAL PROCESSING DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

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MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

STRUTHERS WELLS *Corporation*

Struthers Wells

TITUSVILLE, PA.

PLANTS AT TITUSVILLE, PA. AND WARREN, PA.

Offices in Principal Cities

(To obtain more data on advertised products see page 122)

AUTO-LITE

for
EYE
LEVEL
READING

Auto-Lite Temperature Indicators are ideal for use in processing and storage rooms, and for installation on equipment where temperature indication is desirable.

Model F-1 (illustrated) is available with maximum visibility dial; choice of temperature ranges from minus 60°F to plus 750°F; flexible tubing for remote reading or rigid stem for direct mounting. Adjustable electrical alarm contacts slightly higher. Priced from $22.

Send for new catalog describing Auto-Lite Temperature Indicators and Recorders.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
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TEMPERATURE INDICATORS AND RECORDERS

A Book You Should Have on Mechanical Sealing...

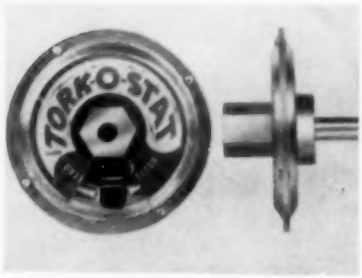
A complete reference catalog on Dura Seal—the engineered mechanical seal that rotates with the shaft. Amply illustrated . . . specific applications . . . installation data. A fact book of real value to designers, operators and maintenance departments.

WRITE FOR DURA SEAL CATALOG NO. 455 PP
DURAMETALLIC CORPORATION
KALAMAZOO, MICHIGAN

fan section. A dry air stream crosses this coil and removes any super-heat. Oil vapor present is liquified and removed by a separator in the gas line, ahead of the condensing coils.

Sizes are available in four ratings (for ammonia): 90, 120, 180, and 240 tons. The dimensions of the largest size are approximately 13 ft. long, 16 ft. wide, and 10½ ft. high. **Niagara Blower Co.,** 405 Lexington Ave., New York 17, N. Y.

Circle No. **19** *on Reply Card*



Overload Protector

. . . **safeguards machinery** from jamming and overloading. This particular model is designed for take-off drives.

A self-contained unit, the Tork-O-Stat releases itself when an overload or jam occurs, resetting itself when the overloading condition is corrected. Three spring steel fingers, attached to the driving shaft, are engaged in depressions of a hardened steel back plate. When the units rating is exceeded, the fingers ride up and rotate over the back plate ridges. This slipping action continues until the overload has been corrected. The fingers automatically reset and positive drive resumes.

Type "S" is for use with belts, chains, gears or coupling drives. Models are available in 10-15-20-30-40- and 60 in.lbs. torque ratings. A variety of bore sizes can be supplied. List prices start at $9.95. **Machine Accessories,** 6 East Franklin Ave., Minneapolis 4, Minn.

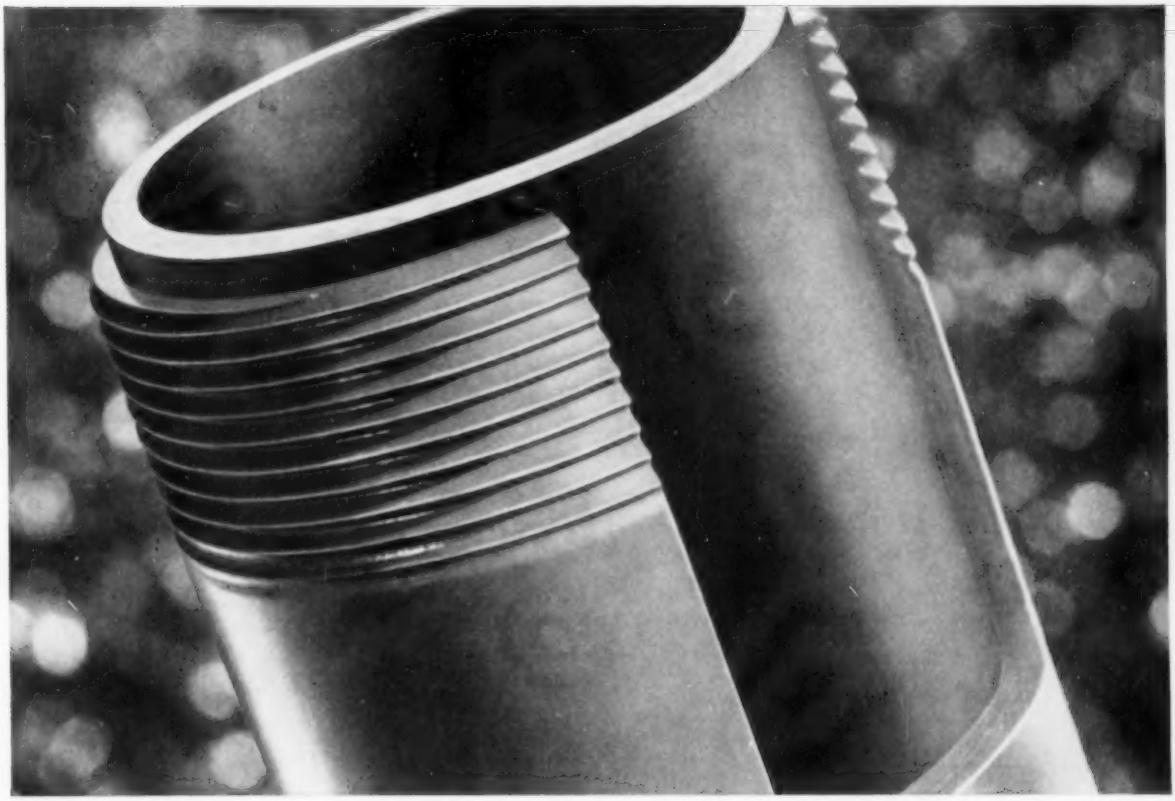
Circle No. **20** *on Reply Card*

Plastic Pipe Fittings

. . . **are chemically inert** to a wide variety of corrosives. They are made of "Fluoroflex-T," a fluorcarbon resin.

These fittings are recommended for applications involving acids and caustics, steam, jet fuels, and gases and vapors under extreme conditions of temperature. The pipe elbow is available in 45° and 90° short radius types. The molded bellows come in 1-, 1½-,

DOW



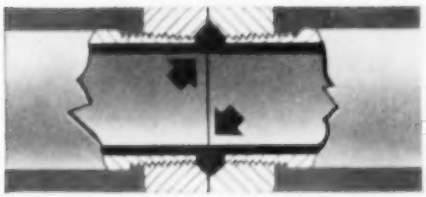
You can see why Saran Lined Pipe cuts corrosion costs

It's made of corrosion-resistant saran swaged into rigid non-bursting steel . . . liquid never touches metal in these installations

Here's your best way to convey acids, alkalies and other corrosive liquids—saran lined pipe, fittings and valves. This modern piping is corrosion resistant . . . forms snug, leakproof joints . . . is available for working pressures up to 150 psi. Fittings and valves are also available in steel for working pressures to 300 psi.

Installation costs are low with saran lined pipe, fittings and valves. Saran lined pipe can be cut and threaded in the field with available pipe-fitters' tools. Its rigidity means few supporting structures are needed.

Saran lined pipe has an outstanding record of trouble-free performance in the chemical, petroleum, waste, pulp and paper, metal finishing, and food processing industries. For further information send in the coupon at the right. THE DOW CHEMICAL COMPANY, Midland, Michigan.



Liquid never touches metal in saran lined pipe even at a flanged connection like this.

Saran Lined Pipe Company
2415 Burdette Avenue
Ferndale 20, Michigan
Dept. SP625F

Please send me information on saran lined pipe, valves and fittings.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

Saran Lined Pipe is Manufactured by The Dow Chemical Company, Midland, Michigan

you can depend on DOW PLASTICS

DOW

Safe and Sure Packing for HOT OIL CHARGE PUMPS

...ends packing blowouts and hot oil flashes

STYLE 101-AL (Aluminum)

Available in spirals and die-formed rings to specific stuffing box sizes.

Made of continuous thin ribbons of soft aluminum foil, spirally wrapped, crinkled and folded about a small core of pure dry asbestos roving, and squared to desired size.

ADVANTAGES . . . Minimum wear on shaft sleeves . . . Easy adjustment by gland takeup . . . Operation at highest temperatures . . . Easy cutting of rings from stock spirals.

SERVICE . . . High Temperature centrifugal hot oil charge pumps . . . hot oil valves . . . Diphenyl valves . . . still necks.

JOHN CRANE

High Temperature

METALLIC PACKING

"John Crane" High Temperature Metallic Packings have been developed, as a result of years of extensive research, to withstand temperatures as high as 750°F.—discharge pressures of over 800 lbs.—speeds of 3600 rpm or more.

These "John Crane" Packings have been in continuous use on heavy and light hot oil charge pumps for years without maintenance or attention. One user reports . . . "seven years of continuous service and still as dependable as the day it was installed."

For a truly dependable packing for hot oil charge pumps, specify "John Crane" Style 101-AL. For the right combination of "John Crane" Packings to meet your specific needs, consult with experienced Crane Packing Company field engineers.

Send for catalog giving detailed information on "John Crane" complete line of packings for all services. Crane Packing Co., 6432 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

2-, and 3-in. diameters. Custom designs and shapes may be requested. **Resistoflex Corp.**, Belleville, N. J.

Circle No. **21** *on Reply Card*

Free Trade Literature

Catalysts

. . . their history and the different types available: *Harshaw Catalysts* lists typical catalysts for dehydrogenation, reforming, desulfurization, chlorination, hydrogenation, organic syntheses and dehydration. A chronological tabulation traces the development of all types of refining catalysts. Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.

Circle No. **22** *on Reply Card*

Synthetic Ammonia

. . . four basic plant types: steam methane reforming, catalytic partial oxidation, non-catalytic partial oxidation, and low temperature raw gas separation. These four processes are described and presented with flow diagrams for each in a booklet: *Synthetic Ammonia—4 Basic Plant Types.* Presented are two economic cases, which compare the use of coke oven gas or natural gas as the raw material. M. W. Kellogg Co., 225 Broadway, New York 7, N.Y.

Circle No. **23** *on Reply Card*

Asphalt Blender

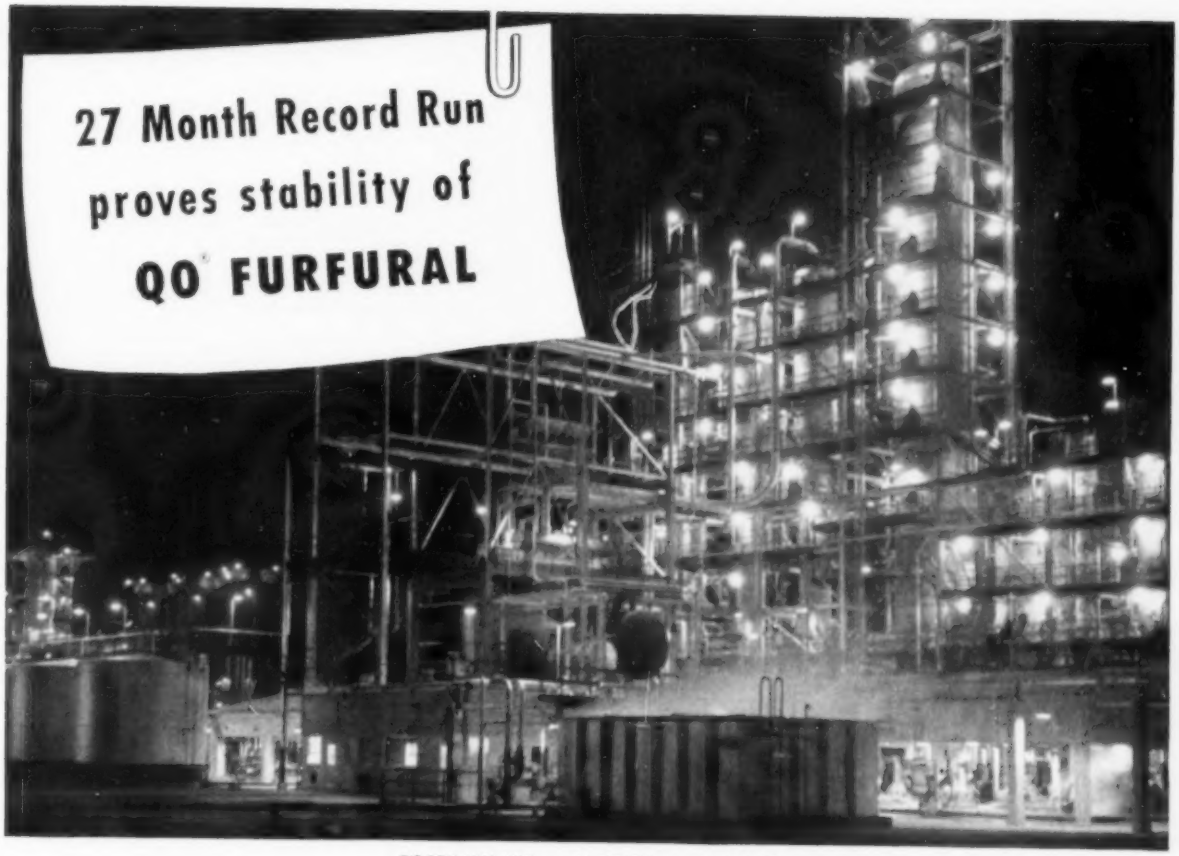
. . . for eliminating the problems of manual batch-blending asphalt cutbacks: *Application Memo M28* describes the operation of an automatic blender, which delivers to tank trucks or cars through a product cooler. Desired blends may be uniformly duplicated in any number of batches. A detailed flow diagram and a description of a typical installation are presented. Proportioneers, Inc., 345 Harris Ave., Providence, R.I.

Circle No. **24** *on Reply Card*

SAMA Standards

. . . covering thermometers have recently been published. These tentative standards are: RC4-10-1955, *Bimetallic Thermometers;* RC5-10-1955, *Resistance Thermometers;* RC6-10-1955, *Filled System Thermometers;* RC7-10-1955, *Glass Stem Industrial Thermometers;* and RC8-10-1955, *Thermocouple Thermometers (Pyrometers).* After a period of two years these standards

27 Month Record Run proves stability of QO® FURFURAL



CIT-CON LUBE UNIT — 27 MONTHS — NON-STOP!

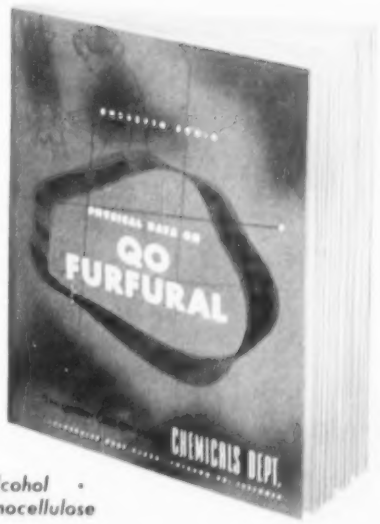
No shutdowns in 27 months! That's how long Cit-Con Oil Corporation ran its furfural lubricating oil unit non-stop . . . using QO furfural as the selective solvent.

We salute Cit-Con engineers. Their operating methods kept Cit-Con's system in good shape all through this run, and capitalized on furfural's stability to produce a continuous flow of high quality lubes.

You can also measure QO furfural's stability by its recovery ratio. In well operated refineries, solvent losses run only 0.02% of the furfural cycled.

No wonder QO furfural is first choice among so many refineries throughout the world. Other reasons? High selectivity. Low cost. Economical storage. Easy handling. Free from excessive toxicity. Year 'round availability.

By all means, write for our helpful new Bulletin 203-A: "Physical Data on QO Furfural." And remember—your Quaker representative is at your service.



QO CHEMICALS

Furfural • *Furfuryl Alcohol* • *Tetrahydrofurfuryl Alcohol* • *Furoic Acid* • *Fur-Ag® Conditioner* • *Furafil® Lignocellulose*

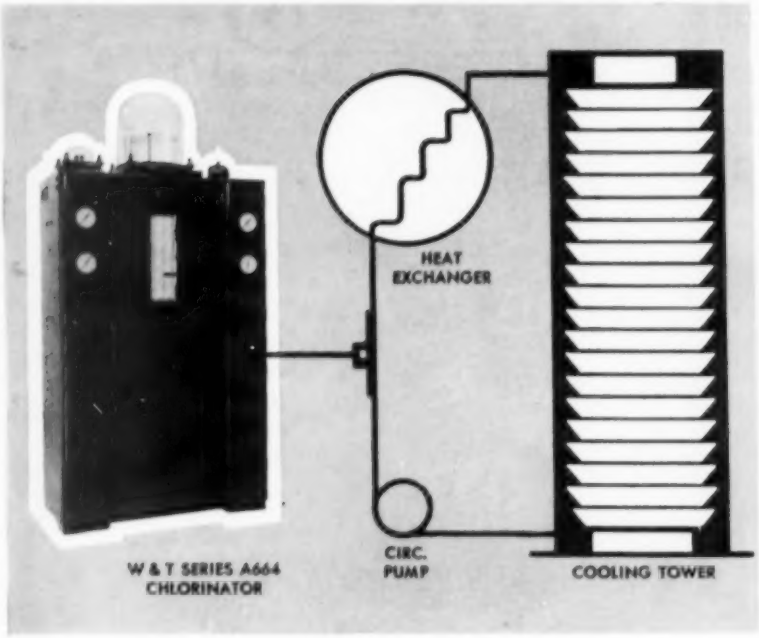
The Quaker Oats Company

CHEMICALS DEPT.

339Z The Merchandise Mart, Chicago 54, Illinois
Room 539Z, 120 Wall St., New York 5, N. Y.
Room 439Z, 3000 No. Going St., Portland 11, Oregon

In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England • **In Europe:** Quaker Oats-Graanproducten N.V., Rotterdam, The Netherlands, Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France, A/S "Ota", Copenhagen, S. Denmark
In Australia: Swift & Company, Pty., Ltd., Sydney • **In Japan:** F. Kanematsu & Company Ltd., Tokyo

Slime Control...



...Chlorination of Cooling Water Circuits

Heat transfer losses caused by slime formation on condenser and heat exchanger water-side surfaces can be eliminated by chlorination of the cooling water. Water and air-borne organisms—the cause of slime formations—are effectively and economically controlled by Wallace and Tiernan chlorination systems.

The Wallace and Tiernan Series A-664 Chlorinator shown above is one of a complete line of W&T chlorination equipment, designed to give dependable chlorination at all feed ranges. It is used at large plants where cooling water chlorine requirements call for a durable high capacity unit.

We Invite Your Inquiries

Technical information on cooling water chlorination is available in our free booklet, RA-2061-C. Bulletins on chlorination of industrial process water and industrial waste treatment are also available. Write us for your copy.

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CD-40

will become a standard of the industry. Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, Ill.

Circle No. **25** *on Reply Card*

Glass Lined Reactors

. . . with hydraulic-driven agitators, available for laboratory and pilot plant use: *Bulletin No. 927* describes this new line of corrosion-resistant vessel, which is similar to the large manufacturing type. *Data Sheet Number 30* describes the hydraulic and air motor drive for this type of reactor. With a hydraulic drive all belting and vessel-mounted electric motors are eliminated; the unit is completely enclosed and explosion proof. The oil pumping unit, mounted at a safe distance from the vessel, is connected by hydraulic hose. The Pfaudler Co., Rochester, N.Y.

Circle No. **26** *on Reply Card*

Flotation Unit

. . . for use in refinery waste treatment plants: *Gibbs Flotation Unit*, a 20-page brochure describes the construction and operation of an air flotation unit for waste treatment. A schematic flow diagram illustrates the operating principle of quiescent air bubble, induced flotation. Specifications and construction features are detailed. F. S. Gibbs, Inc., 2300 Washington St., Newton Lower Falls 62, Mass.

Circle No. **27** *on Reply Card*

Laboratory Equipment

. . . new pieces are listed in: *What's New For The Laboratory, Number 25, 1955*. Included are serological pipettes, humidity apparatus, freeze-drying apparatus, a mechanical extractor, fluorocarbon lubricant, high vacuum pump and other new pieces of laboratory equipment. Scientific Glass Apparatus Co., Inc., Bloomfield, N.J.

Circle No. **28** *on Reply Card*

Inert Gas Welding

. . . by a low cost method: a 12-page reprint, *Carbon-Dioxide-Shielded Consumable-Electrode Arc Welding*, deals with the methods of supplying carbon dioxide and its flow characteristics. The chemical activity, operating characteristics of this gas, and the properties of the metal welded by the process are also discussed. Air Reduction Sales Co., 60 East 42nd St., New York 17, N.Y.

Circle No. **29** *on Reply Card*

ALL AROUND THE WORLD . . . YOU WILL SEE

PROCON BUILDING

Forgive us for paraphrasing a trite slogan but actually "The sun never sets on a Procon construction project." From a refinery in Australia to a petrochemical plant in England, the world around . . . Procon is building.

The broad experience gained, the highly skilled personnel developed in Procon's wide-spread arena of operation, can be harnessed to your construction problems —to give you full confidence in a job done rigidly to specifications and time requirements.

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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

(To obtain more data on advertised products see page 122)

ACT NOW!

HANDLE DANGEROUS CLEANING PROBLEMS IN COMPLETE SAFETY WITH A . . . Doyle EXPLOSION PROOF VACUUM CLEANER

DOYLE VACUUM CLEANER COMPANY
243 Stevens Street, S.W., Grand Rapids, Michigan

Please send, without cost or obligation, detailed information and specifications on the Doyle EXPLOSION PROOF Vacuum Cleaner!

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FIRM ..... STREET .....

CITY ..... ZONE ..... STATE .....

Daily cleaning of hazardous locations can be just a routine operation with the Doyle Explosion Proof Vacuum Cleaner. Cleans walls, floors, bins, beams, pipes or ceiling in critical areas where an ordinary vacuum could not be used.

The unit safely recovers liquids as well as dry materials in areas containing highly explosive or inflammable dust and gases. Underwriter's Laboratories approved, (see U.L. listings) the entire unit is static conductive, constructed and designed to eliminate any exposed sparking which may occur in normal operation.

Make a hazardous place, a safe place . . . clean it regularly with a Doyle Explosion Proof Vacuum Cleaner. Write for full details.

* The Doyle EXPLOSION PROOF Vacuum Cleaner is U. L. Approved for Safe Operation Under Class I, Group D and Class 2, Group G.

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2. Atmospheres containing starch, flour, or grain dust.

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A NEW, EASY WAY TO ORDER REPRINTS

You can now use the Reader's Service Card in this issue of PETROLEUM PROCESSING to order reprints. Here's how:

- Check the list of reprints on page 123.
- Circle the proper "R" letter on the Reader's Service Card (Area "C").
- Fill in your name and address—and send the card to us.

We'll bill you with the reprints

What's New!

Temperature Table

. . . for conversions from —460 to +4000 degrees is available in a handy 8½ x 11-in. form. This two color chart converts degrees Fahrenheit to Centigrade, or vice versa. Also included are the temperature ranges of various sensing elements—thermocouples, resistance bulbs and radiation heads. Maximum limits for both continuous and intermittent services are shown. Thermo Electric Co., Inc., Rochelle Park Post Office, Saddle Brook, N.J.

Circle No. **30** *on Reply Card*

Chromatography Catalog

. . . lists the latest in equipment for chromatographic and electrophoresis work. This 19-page catalog includes detailed descriptions and prices for apparatus designed to cover all normal requirements in this field of analysis. Fraction collectors, migration chambers, densitometers, spectrophotometers—everything needed for work in this field is included. Harshaw Scientific, Division of Harshaw Chemical Co., Cleveland 6, Ohio.

Circle No. **31** *on Reply Card*

Model Kit

. . . for the "do-it-yourself" designer: a brochure describing the simple but adequate kit of model parts for layout of chemical plants and refineries is now available. Listed are the parts which make up the standard kits; special parts can be ordered separately. Industrial Models, Inc., 2311 Sconset Road, Wilmington 13, Del.

Circle No. **32** *on Reply Card*

Pumping Stations

. . . for liquid petroleum: *Technical Data Bulletin No. PL-2* describes the functions of pipe line pumping stations, the various types of pumping equipment, and the control systems for regulating them. Copies of the bulletin can be obtained by writing directly to Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Avenues, Philadelphia 44, Pa.

Do not use Reply Card

Heat Exchanger Data

. . . presented in a technical catalog will aid in selecting equipment: *Catalog 552* deals with instantaneous heaters and storage heater coils. Simplified performance curves present informa-

Introducing...

The New BS&B Type 1460 Temperature Controller

Vapor-Tension Sensing System

Bulb Range	Recommended Working Range
0-100° F.	20-90° F.
40-140° F.	60-130° F.
40-240° F.	90-220° F.
100-350° F.	175-335° F.

Gives Positive Fluid-Flow Control Through Diaphragm Operated Valves, Based On Temperature Variations

The new BS&B Type 1460 Temperature Controller or Pilot is equipped with an external vapor-tension thermal system to actuate the power unit in the pilot.

Except for this actuating mechanism and the temperature indicator which is an integral part of it, the 1460 Controller has all of the excellent features offered in the well-known BS&B Type 1440 Control Pilot—including the ¼" supply medium reducing regulator and two pressure gauges.

This unit is especially suited for translating temperature variations to direct flow-control of fuel, or of heating or cooling medium, through diaphragm operated valves.

FEATURES

- Vapor-Tension Sensing System
- Choice of Temperature Ranges
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- Parts Interchangeability With BS&B 1440 And 1450 Pilots Reduces Maintenance Cost And Parts Inventory.

Ask your BS&B Representative for more details—or write to . . .

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BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-D2

7500 East 12th Street Kansas City 26, Missouri

LINDBERG LABORATORY HOT PLATES

BOILING? EVAPORATIONS? HEATING?

Whatever your need may be you can fill it perfectly with one of these Lindberg Hot Plates.

Model H-2—(illustrated)—Plate working surface 12" x 20". Power rating 2600 watts. Power service 115-230 v. 50/60 cycle. 950° F. maximum temperature.

Model H-1—Plate working surface 10" x 12". Power rating 1300 watts. Power service 115-230 v. 50/60 cycle. 950° F. max. temperature.

Model H-3—Plate working surface 12" x 30". Power rating 3900 watts. Power service 230 v. 50/60 cycle. 950° F. max. temperaure.

Model H-5—Plate working surface 5" x 22". Power rating 1300 watts. Power service 115-230 v. 50/60 cycle. 950° F. max. temp. Four clamp sockets accommodate standard dovetail support clamps.

This new low cost Lindberg Pyrodisc is the ideal portable hot plate for the user whose volume of hot plate work is limited. Top plate 8" diameter. Power rating 660 watts. Power service 115 v. 50/60 cycle. 750° F. Maximum Temperature.

All Lindberg Hot Plates offer many exclusive features, and are available for immediate shipment. Order from your laboratory equipment dealer, or for additional information, ask us to send you Bulletin No. 1001-A.

LINDBERG LABORATORY DIVISION
Lindberg Engineering Company
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tion which can be used by engineers, architects and large users of water heating equipment. Sizes and dimensions, temperature rise conversion, pressure-temperature conversion and tips on fouling allowances are subjects all presented in chart form. E. C. Cooley Co., 1186 Folsom St., San Francisco, Calif.

Circle No. **33** *on Reply Card*

Piping Flexibility Analysis

. . . what it is and how it can cut piping design and construction costs: a 12-page brochure, *Piping Flexibility Analysis*, details how M. W. Kellog Co. uses this method, along with a piping model test and electronic computing facilities, in the design of piping networks. Presented is a solution of a typical piping stress problem by both the general analytical method and the model test. M. W. Kellogg Co., Fabricated Products Div., 225 Broadway, New York N.Y.

Circle No. **34** *on Reply Card*

Chemical Pumps

. . . for chemical sump, tank car unloading, underground tanks, and other applications where air and vapor handling capacity is needed: *Bulletin No. W-350-B13*, describes the major component parts of self-priming, centrifugal pumps. One section is devoted to a description of the physical properties and corrosion resistance of Worthite, the patented material of construction. Worthington Corp., Harrison, N.J.

Circle No. **35** *on Reply Card*

Water Vapor

. . . and how to measure it is the subject of a 12-page bulletin, *The Measurement of Water Vapor and Other Gases*. Subjects considered are: gravometric, dew point and wet and dry bulb methods—as well as less commonly used methods, such as constant volume, convection, diffusion and other experimental schemes. Pittsburgh Lectridryer Corp., P.O. Box 1766, Pittsburgh 30, Pa.

Circle No. **36** *on Reply Card*

Process Plants

. . . a review of the design, engineering and construction work done by Blaw-Knox Co. in this field: *Process Plants by Blaw-Know*, a 24-page booklet outlining their work in high temperature and low temperature plants, natural and synthetic fuels, waste re-

Grandma **likes** wax... Motors **don't**

GB ***builds de-waxers to fit your exact process requirements . . . tops in efficiency and long, dependable service.***

De-waxing and de-oiling rotary drum vacuum filters designed and engineered by Goslin-Birmingham have been recognized for many years as the standard for the industry. A continuous program of advancement and improvement in design, coupled with a reputation for exacting workmanship, has made G-B filters the reliable choice of leading refineries everywhere.

The newest design G-B MEK filters are 12′-0″ x 18′-8″ and provide 700 square feet of filtering area. Units are available with bearings supported on the vat, with a much stronger vat and supporting feet. Propane de-waxing filters range up to 400 square feet filtering area.

Installing the filter drum in a propane de-waxing filter. The bearings are inside the vat and involve a very unique method of holding the wear plate against the valve.

For more complete information . . . *including recent test data from many foreign refineries . . . please write our Filter Engineering Department. There is no obligation.*

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J-M BLAZECRETE builds longer lasting refractory linings...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

Blazecrete* linings last longer because they resist spalling, withstand slagging action, and are not harmed by rapid temperature changes.

Thus you cut down on refractory maintenance costs—and you save on labor costs, too, because Blazecrete goes on fast. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place. When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete may be applied easily without laborious ramming or tamping.

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix—can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

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Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic-setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

covery, petroleum and petrochemicals—as well as other process fields. Blaw-Knox Co., Chemical Plants Div., Pittsburgh 30, Pa.

Circle No. **37** *on Reply Card*

Fatty Acids

. . . their effect in performance of lubricating greases: *Using Fatty Acids in Lubricating Greases*, a booklet describing the factors for improving the uniformity and performance of lubricating grease. The advantages of using fatty acids as replacement for tallow and other glycerides are summarized. Various examples of improved grease formulations are suggested. Fatty Acid Division, Soap Association, 295 Madison Ave., New York 17, N.Y.

Circle No. **38** *on Reply Card*

Lithium Grease

. . . a review of its history and formulation: *Foote Prints, Vol. 27, No. 2, 1955*, presents an article on the manufacture of this multipurpose grease, which is a comparative newcomer to the old line of industrial lubricants. The reasons for using napthenic stocks rather than paraffin base lube stocks are outlined. Foote Mineral Co., 18 West Chilten Ave., Philadelphia 44, Pa.

Circle No. **39** *on Reply Card*

Jet Vacuum Pumps

. . . for installations needing suction pressures from 4-in.Hg absolute to 10mm Hg absolute: *Bulletin 5H2* lists typical performance characteristics, sizing data, and sizes and dimensions for two-stage steam jet vacuum pumps. Applications for both condensing and non-condensing units are described. Included also are operating instructions and a description of materials of construction. Schutte and Koerting Co., Cornwells Heights, Bucks Co., Pa.

Circle No. **40** *on Reply Card*

Downhill Pumps

. . . for pumping from high suction pressures to lower discharge pressures: *Bulletin No. 855* details the operation and applications for the new "Minus Delta P" line of pumps for controlled volume. Included are specifications, capacities and features of this unit designed for additive injection, proportional feed and fluid sampling under special pressure conditions. Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pa.

Circle No. **41** *on Reply Card*

Motor oils compounded with ORONITE ADDITIVES

give your customers what they want

Reduced engine wear. Your customers are aware of the greater demands placed on motor oils by the modern, high-compression engine. And with superior oil performance and engine protection provided by Oronite lube oil additives, you can gain a better sales position with your finished oils. With Oronite additives you can prove "reduced engine wear" to your customers.

Oronite's flexible program of custom-formulation to your base oil and individual needs can provide your customers with an exclusive, tailored-to-order motor oil. Why not talk it over with an Oronite lube oil additive specialist. Contact the Oronite office nearest you.

Custom-formulation for individual oil marketer —an Oronite specialty!

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Diesel-Loading pumps with EC&M Div. 2 Starters.

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50,000 KVA
Interrupting Capacity
MOTOR STARTERS

OUTSTANDING ADVANTAGES

1. Reduced floor space
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8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete
10. Self-contained bus and pot-heads are optional

Petroleum engineers specify these Starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: Type III weather-resisting enclosure with drip-proof roof, tank-cover and front-cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . overload and control relays in flanged (Class I, Group D) enclosure with removable cover . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit. "Stop circuit" opens without delay when "Off button" is pressed.

EC&M 2200-5000 volt Starters are also available in Totally Oil-immersed Division 2 Style and in Division I style. Both are available with Oil Disconnect Switch (for main line).

Write for 16-page Booklet 1062 for complete details.

THE ELECTRIC CONTROLLER & MFG. COMPANY

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What's New!

Process Pumps

. . . for petroleum uses: *Form 7094-B* describes the full line of pumps available for refinery applications. Featured are detailed drawings of pumps for moving hot liquids, slurries, and general process fluids—as well as detailed descriptions of mechanical features. A helpful chart shows (in graph form) the interchangeability of all pump parts; possible modifications for special services are also described and illustrated. Dimensions for both top-suction and end-suction models are listed in a separate table. Ingersoll Rand, 11 Broadway, New York 4, N.Y.

Circle No. **42** *on Reply Card*

Metal Hose

. . . its use and selection: *Catalog #152* describes the full range of flexible metal hose products, along with complete coupling data. Specifications, applications, and dimensions of each type are covered. Included also is a 4-step method recommended for the proper selection of this product. Charts of working pressures and line size are included. Flexonics Corp., 1315 S. Third Ave., Maywood, Ill.

Circle No. **43** *on Reply Card*

Petroleum Processing Index

. . . for 1955: including subject and author indexes for all feature articles and regular departments for the 12 issues of this magazine published during the past year. Available now from McGraw-Hill Petroleum Publications, 330 West 42nd St., New York 36, N.Y. or . . .

Circle No. **44** *on Reply Card*

Refining Statistics

. . . a supplement to the book: *Statistics of Importance to Refiners*, issued by the Western Petroleum Refiners Association. Revised information on 24 pages is available to the holders of the original book. Write direct to the Western Petroleum Refiners Association, 1428 Hunt Building, Tulsa 3, Oklahoma.

Do not use Reply Card

Tubing and Piping

. . . for subzero service: *Bulletin TB-357* describes the special types of tubing to use for low temperature processes—such as ethylene purification, propane dewaxing, synthetic rubber production and others involving tem-

Nicholson *steam trap* simplicity *gives you*

peak performance, low-cost maintenance

Write, today, for your copy of new Bulletin 10-55 for detailed information.

Nicholson simplicity of design and operation pays off big in any plant . . . in peak performance for petroleum processing . . . in easy, low-cost maintenance. Nicholson traps offer the most effective method for discharging condensate and air from steam lines.

- **one moving part—big husky bellows.**
- **positive shut-off—no waste of steam.**
- **high capacity—effective use of large orifice.**
- **each unit service tested—with steam.**

When less than the best won't do, specify Nicholson.

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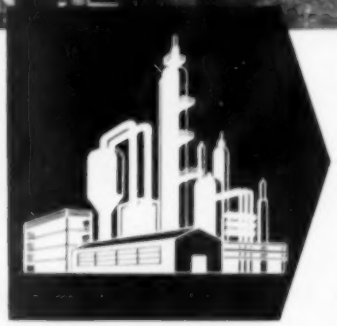

Weathercoat— a petroleum product— protects outdoor refinery vessel insulation

In refineries and petrochemical plants throughout the nation, operators are turning to Laykold Weathercoat for protection of insulation on outdoor units.

"EFFICIENCY PROTECTION"

Most modern insulation materials depend on "dead air space" between particles for their insulative value and efficiency. If water replaces this "dead air" the efficiency is lost.

A PRACTICAL RAINCOAT

Laykold Weathercoat seals insulation material (whether block or bulk) against water vapor or moisture. And—it remains "alive" and resilient to resist rupture due to dimensional changes and vibration.

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Inglewood, Calif. Oakland 1, Calif.
Portland 7, Ore. Washington 5, D. C.
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peratures as low as —323°F. Some types of steel, showing good tensile and yield strength properties at room temperature, exhibit brittle qualities and poor ductility when subjected to low temperatures. Selection of the right type for these operating conditions is covered in this booklet. Babcock & Wilcox, Tubular Products Division, 161 E. 42nd St., New York, N.Y.

Circle No. **45** *on Reply Card*

Electric Heaters

. . . for curing many winter headaches: *How to solve Winter Problems with Electric Heat*, a 16-page booklet illustrating interesting applications of small heaters to avoid freezing and icing. How to use heated cable, straight or formed tubular heaters, flat or curved strips, cartridge and finned heaters—applications for all these types are described along with pictures of installations. Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

Circle No. **46** *on Reply Card*

Magnetic Speed Control

. . . allows adjustable control of existing constant speed motors. *Bulletin, No. 4400-PRD-229* explains the use of the "Ampli-Speed" drive, which can be used up to 75 hp for constant torque loads: Fans, centrifugal pumps, and compressors up to 95 hp can be controlled by this magnetic amplifier speed control, within 2% of control knob setting. Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Circle No. **47** *on Reply Card*

Nickel Alloys

. . . as produced in the largest specialty mill in the world, is the subject of a new booklet, *This Is Inco's Huntington Works*. Tracing the production of high nickel alloys from the mine to the mill, the 47-page book unfolds a complete story of all operations involved. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Circle No. **48** *on Reply Card*

Solenoid Valves

. . . for air, water, and oil service. *Bulletin 5S-A* describes air valves for pressures of 250, 1000, and 1500 psi; *Bulletin 5S-H* covers oil valves with operating ranges of 250, 1500, and 3000 psi; and *Bulletin 5S-W* describes

New low prices make

Aerocat® catalysts

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- • • first to bring you fully balanced HI PV+ Catalysts
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Cyanamid leads the way again by offering you regular and high alumina catalysts at new low prices.

Technological improvements have brought savings that can be passed along to you. And because synthetics give higher octane yields than natural catalysts, these new low prices make AEROCAT Catalysts even greater bargains for the refiner.

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with the meter on the door

New convenience has been built into the well-known F3 Oxygen Analyzer . . . a meter on the door provides readings at the sampling point for making calibration checks, process changes, etc. In fact, complete analyzing, calibrating and indicating components are now incorporated into the single F3 unit—at no extra cost!

Use The Model F3
ON OPERATIONS LIKE THESE . . . TO MAKE SAVINGS LIKE THESE

COMBUSTION Boilers, Kilns, Direct-Fired Heaters, Stills, etc.	*Higher combustion efficiencies at lower fuel costs*
PROCESSING Air Liquifraction . . . Processing Butadiene, Acetylene and Similar Gases	*Better product quality with minimum oxygen or air contamination*
PLANT SAFETY Hydrogenation, Hydrofining, Gas Compressors, Sulfur Grinding, etc.	*Control explosive atmospheres, reduce fire risks, minimize plant and personnel hazards*

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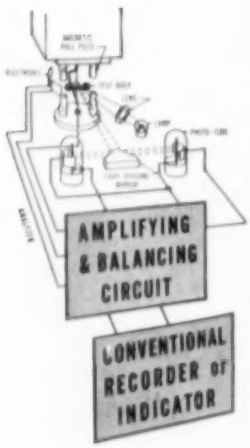

The various applications highlighted above are only a few of the many ways Arnold O. Beckman Oxygen Analyzers—industry's great new profit builders—are being used by progressive operators to boost profits, cut costs.

These are the *only* oxygen analyzers that *continuously* measure process streams by an advanced magnetic principle that provides *direct physical measurement of the oxygen itself*—not of some secondary relationship.

Heart of the unit, as illustrated, is a dumbbell-shaped test body suspended in a magnetic field. Sample gas surrounding this test body causes it to rotate in the field, depending upon the oxygen content of the gas. The movement of a light beam, reflected by a small mirror on the test body, is measured by simple electronic circuits . . . and the result indicated directly on a conventional recorder or indicator. It's simple, positive, accurate!

No chemicals—filaments—catalysts cams—complicated mechanical parts!

Send for Helpful Free Literature which describes this unique operating principle in detail—explains its many advantages and applications. When writing, outline your particular operations—we'll gladly supply specific information.

Ask For Data File 16J-26

FEATURES OF THE F3

Many Ranges: Full scale ranges of 0-5%, 0-10%, 0-15% O_2 and higher.
Accuracy: 1% of full scale.
Multi-Ranges: Any instrument may be supplied with two or more ranges.
Note: For ranges narrower than 0-5% O_2 ask about the Model G2.

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Instruments for Science and Industry
1020 MISSION STREET
SOUTH PASADENA, CALIFORNIA

water valves for pressures of 250, 1500, and 3000 psi. All bulletins include valve characteristics, flow patterns, photographs, and overall dimensions. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle No. **49** *on Reply Card*

Tubing Supports

. . . for field installation: *Bulletin No. 955-D* lists the advantages of the P-W system for running instrument tubing, as well as the standard units available. Dimensions, recommended loadings, and general specifications are included as an aid to designers. P-W Industries, Inc., 4500 E. Melrose St., Philadelphia 24, Pa.

Circle No. **50** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in October, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details or literature please use the regular Reply Card in this issue.

High Vacuum Pumps

. . . from ¼ to 40 hp.: 52-page *Catalog No. 425* describes compound single-stage simplex, single-stage duplex and two-stage mechanical booster high vacuum pumps, and presents engineering data in the form of conversion tables, charts, formulae, etc. New York Air Brake Co., Kinney Manufacturing Division, 3640 Washington St., Boston 30, Mass.

Circle No. **51** *on Reply Card*

New Tower Packing

. . . for distillation, absorption, fume scrubbing, etc.: bulletin *Spraypak* describes construction, performance, and mechanical design. Fractionating Towers, Inc., 5711 Boulevard East, West New York, N. J.

Circle No. **52** *on Reply Card*

Process Automation

. . . for the petroleum and chemical industries: *Kellogram, Issue No. 3, 1955 Series*, discusses the concepts of automation, gives diagrams to illustrate the basic functions of instruments used in automatic control—such as radio-isotopes; discusses data reduction systems, electronic instru-

From Regina to Saudi Arabia

B-L VESSEL LININGS SET RECORD AFTER RECORD FOR DEPENDABLE PERFORMANCE

It looks like a Cook's Tour—but it isn't. Instead it's a listing of recent Bigelow-Liptak refinery installations in far-flung corners of the world.

There are good, solid reasons for this world-wide preference for Bigelow-Liptak jobs. In the first place from B-L's years of experience has come a *complete castable package*. Insulating- and abrasion-resistant castables are *engineered, furnished* and *installed* by the same company—which means just one contract and one responsibility.

The overall result of this all-in-one engineering is exceptional durability and performance. B-L refractory installations have established world records for continuous operation. For example, after initial runs of 785 and 610 days, B-L linings were in perfect shape—required no repairs during shutdowns.

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• Batangas, Philippines	Regenerator and Cyclones
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• Copenhagen, Denmark	Kiln-Reactor
• Antwerp, Belgium	Kiln
• Norco, La.	Regenerator and Cyclones
• Altona, Australia	Reactors
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Circle No. **53** *on Reply Card*

Stainless Tubing and Pipe

. . . of the seamless type: *Bulletin TB-355* contains information for the engineers and designers. Includes the attributes of stainless steel and how it is fabricated, tables of analyses, mechanical properties, creep strength, physical properties, and oxidation resistance of nine of the most popular stainless tubing steels. Tubular Products Div., The Babcock and Wilcox Co., Beaver Falls, Pa.

Circle No. **54** *on Reply Card*

Flow Indicator

. . . **with standard pipe fitting body** permits easy installation in any line.

The FI-200 is designed so that flow (or flow stoppage, if desired) will actuate a switch to operate a warning signal or provide shutdown. Construction is of marine bronze and plastic, both chemically inert to oil and fuels. The lead wires are jacketed with duplex nylon, and the switch unit is hermetically sealed in glass.

Sizes available range from ¼ to 3 in. Normal models are designed to function for any flow over 1.5 gpm, with other capacities obtainable on special order. **Gems Co.,** 64 Welles Drive, Newington, Conn.

Circle No. **55** *on Reply Card*

High Pressure Valve

. . . **provides precise settings** because of its micrometer stem.

Designed for bleeding and metering pressure letdown control, this new "Micro-Valve" operates on the principle of differential screw threads. The slightest turn of the handle makes dial settings on an easy-to-read scale. One complete turn of the handle opens the valve orifice 0.015 sq. in. A positive stop at full closed position prevents misalignment or over-pressure on the seat through excessive tightening.

The valve is available in a wide range of materials, including stainless steel, Hastelloy, and titanium; pressure ratings range from vacuum to 60,000 psi. A complete range of tubing sizes through 9/16 in. is available. **High Pressure Equipment Co.,** Inc., 1222 Linden St., Erie, Pa.

Circle No. **56** *on Reply Card*

Another Job Completed Ahead of Schedule

HIGH YIELDS—LOW COSTS with Kellogg Steam-Methane Reforming

Helping to meet increasing demands for petrochemicals, the Sohio Chemical Company's new anhydrous ammonia plant at Lima, Ohio will have a capacity of 300 tons per day. Engineered to get optimum efficiency from refinery gas and natural gas, and constructed well ahead of schedule, this multi-million dollar project was The M. W. Kellogg Company's responsibility from start to finish.

The M. W. Kellogg Company is privileged to participate in the current expansion program of the Sohio Chemical Company, which provides further evidence of the efficiency of Kellogg's steam-methane reforming process and its unique quench-type reactor. This process is one of four which M. W. Kellogg offers ammonia producers for meeting various local operating conditions. Some idea of the flexibility of ammonia plant design permitted by these four processes, with specific details of each, may be obtained by writing for M. W. Kellogg's 12-page, illustrated booklet, "Synthetic Ammonia—Four Basic Plant Types."

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After the Great Ford Foundation Gift . . .

What Still Remains To Be Done To Provide Decent Faculty Pay

The Ford Foundation's gift of a half billion dollars to our privately supported colleges, medical schools and hospitals, now being distributed, is magnificent. But it will be much more magnificent if it inspires completion of the job to which it gives a lift. So far as the colleges and universities are concerned, this job is primarily to rescue their faculty members from being second-class citizens economically.

Even in a period when we have become accustomed to astronomical financial figures, a half billion dollars remains an eye-popping gift. In fact, it is so imposing that a good many people who don't read the fine print are apt to conclude that it must just about solve the financial problem to which it is addressed.

Goes Only a Small Way

However, we have allowed college professors to fall so far behind the parade financially that the share of the Ford half billion dollar gift going directly to the improvement of faculty salaries ($210 million) will go only a small way financially toward doing what is necessary to provide adequate salaries.

Completion of this job for our privately supported colleges and universities calls for:

1. An increase in faculty salaries at least five times as great as that made possible by the Ford gift merely to restore salaries to their 1939 purchasing power level and an increase fifteen times as great to provide adequate salaries today.

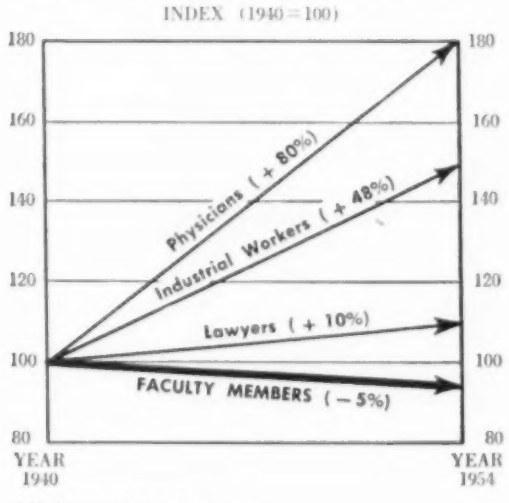
2. Some difficult and courageous decisions by the heads of the colleges and universities in apportioning the grants received by them.

Terms of Gifts to Colleges

The $210 million of the Ford Foundation gift going specifically to improve faculty salaries is being distributed on the following basis: Each of 615 privately supported, regionally accredited liberal arts and science colleges and universities receives a gift about equivalent to its last year's teaching payroll. For ten years only the income from these gifts is to be devoted to raising faculty salaries. After that all the money can be spent in any way the institutions receiving it see fit. There is no requirement that universities having other than liberal arts and science schools limit use of the gifts to improving salaries in these schools alone. They can spread it right through all their faculties if they wish.

In addition to the gift of $210 million specifically directed to increasing faculty salaries, another gift of $50 million goes to a group of 126 institutions selected for specially noteworthy leadership in improving

What's Happened to College Faculty Salaries*



* Real Income before Taxes.

Source: Council for Financial Aid to Education, U. S. Dep't of Commerce; U. S. Dep't of Labor.

the status and pay of teachers. For these schools the individual gifts add about 50% more to the amounts coming from the $210 million fund. They can be used to improve faculty salaries if the institutions choose to do so, but this is not required by the terms of these gifts.

The $210 million plus the $50 million should yield an income of $10-$13 million a year. Even if all this is used to raise salaries, it will be only a small step, however worthy, toward the $200 million per year the colleges need to meet their salary requirements adequately.

Helps Some Who Need It Most

In focussing its gift to improve faculty salaries in privately supported liberal arts and science colleges, the Ford Foundation aims at least part of the help at the spot where it is most desperately needed. Numerous surveys have indicated that the most poorly paid of all college and university faculty members are those in small, privately endowed liberal arts colleges.

But the overshadowing fact is that the teachers in our colleges and universities as a whole are badly underpaid. Just how badly is indicated by the chart above which first appeared in an earlier editorial. (Figures later than those for 1954 are not available.)

The Ford gift will turn the indicator of faculty salaries, which now lies far below the general salary trend, upward a few points. And it will do this in some places where salaries are below the wretched average shown by the chart.

But the Crucial Test Remains

College and university administrators will have the opportunity to extend further the process of getting the help provided by the Ford Foundation gifts where it is most needed. In general, this will mean giving it to senior faculty members, in order to hold experienced teachers and make college teaching attractive as a career. But to make such a division in many schools will take extraordinary fortitude.

The crucial test of the success of the enterprise of the Ford Foundation in raising faculty salaries will lie in whether it prompts the rest of us — college alumni, individuals, business firms and legislators alike — to see that it is a great beginning, not a signal for a recess.

Even with the Ford gifts providing $10-13 million a year, our privately supported colleges and universities must have an increase of about $190 million a year to provide decent faculty salaries.

This is a job far beyond the capacity of the Ford Foundation, imposing though that is. It is a job far beyond the capacities of a few hundred large corporations and a few thousand wealthy individuals. If it is to be done, it is a job at which all of us must work with a will.

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Donald C. McGraw
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

EDITORIALS . . .

What's the Future for 'Mogas'?

A LOT of people have asked us about the future outlook for motor gasoline. They hear talk of the gas turbine and its possible use in automobiles, and they wonder how much longer motor gasoline will be a primary product. They read predictions from Detroit to the effect that a gas turbine-powered car will be in commercial production in the next few years, and they ask if that means the end of the octane race—the end of catalytic cracking and reforming?

We think the answer is simple: The advent of the gas turbine auto will have no quick effect of any consequence on processing. It will be at least 5 years before any appreciable effects are felt by refiners. And it will be 10 years before really drastic effects will be noticed.

The parallel to this situation will be found in the aviation field—although admittedly the military is a much larger factor in aircraft. What is taking place in this field is told in the lead story in this issue: "When the Airlines Fly Jets, What Will It Mean to Refiners?" pages 43-45.

Jet aircraft have been in use for a decade, but the total commercial and military requirements for avgas this past year were over five times what they were in 1946. We are just now entering the big period of transition in aircraft engines. Private operators are ordering jets by the score. But despite the large number of jets which will be put into use in the next few years, avgas demand is expected to drop only about 7% between now and 1960, and maybe another 10% between 1960 and 1965. Jet fuel requirements during that same period, of course, will go up.

It seems to us that essentially the same pattern will be followed in the motor fuel picture. Assume the first turbine autos (on a production basis) come out in 1960. New reciprocating engine cars will still be built—just as new reciprocating engine aircraft have been built. The old ones will continue in operation. And the demand for motor gasoline—of the same or higher quality as the industry is now asked to provide—will hold up. We predict it will hold up until at least 1970—with even a slight increase during the first half of that decade. And then it will begin to drop off.

During this period, more emphasis will be put on treating and finishing middle distillates. Catalytic crackers will be run on heavier stocks and at lower severities. In reforming, more aromatic extraction with recyling of the non-aromatics will be employed. Based on the outlook for avgas, very little of the blending components for aviation gasoline will be released for use in motor fuel.

It appears, then, that refiners will continue to need such processing tools as catalytic cracking and reforming, that existing units will not be obsolete before they have outlived their usefullness, and that additional new units will even be required to maintain capacity.

There's a lesson to be learned from the history of aircraft fuel needs—a lesson of optimism for the future outlook for "mogas."

Needed—The Hand to Turn the Key!

IT took more than average foresight when our forefathers set up the U.S. patent system over 165 years ago. Today, patents are the "keys to progress."

One thing they didn't foresee, however, was today's large research groups, turning out patent applications by the scores. So now the Patent Office finds itself still geared and manned for the single inventor, but coping with an ever-growing flood of requests for patents.

The result is that our industrial health is being seriously crippled by the delay and uncertainty in patent issuances. New developments are kept secret, waiting for the delayed patent protection—instead of being put to use.

One of the problems is the drastic shortage of patent examiners. Over 100 new examiners were added to the Patent Office staff during the last part of 1955. Another 350 are expected to be added this year. These positions must be filled quickly if the patent situation is to improve. Qualifications for examiners include college degrees in engineering or applied science, or with a major in chemistry or physics, or with certain combined credits in these fields.

Salaries start at $4,345 a year, and it is possible to reach $7,570 in 5½ years. The usual liberal government vacation, sick leave and pension benefits are included. Any person interested in patent examining as a career should write the Commission of Patents, Washington 25, D.C.

Though we approve of efforts to speed patent processing, we would like to suggest that more than the hiring of additional examiners is needed. With patent law, language and techniques couched in "patenteese," which serves more to confuse than to clarify, we have another bottleneck.

Even the Patent Office plan to IBM-ize patent searching cannot be fully effective as long as horse-and buggy "patenteese" holds sway. Why not a national conference between the judicial, legal, Patent Office and industrial concerns directly affected by patent techniques. Maybe they could develop a logical set of patent "mechanics" in step with our streamlined, automated age.

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